

JANUARY 6, 1983

A CAHNERS PUBLICATION

EDN

EXCLUSIVELY FOR DESIGNERS AND DESIGN MANAGERS IN ELECTRONICS

Use comparator ICs
to solve new problems

Field-programmable logic
sees revived attention

First EDN
Technical Article
Database

Newest miniature rotary switches withstand the automated production environment



SPECIAL INSERT!
1983 Calendar of
Electronic Industry Events



WORK SMART, NOT HARD.



SAGE TEST PROGRAM DEBUG SOLUTION

CIRCLE NO 16

FAIRCHILD

A Schlumberger Company

SAGE is a revolutionary, real-time software debugging tool that takes you out of the time-consuming maze of finding and fixing errors in test programs.

SAGE reduces test program development time by as much as 40%, while improving overall test program quality and increasing software productivity. SAGE is available as a plug-in option to the new Series 21, as well as Series 20 and Sentry® systems using the M³ operating system.

Combining interactive software with a color graphics terminal, SAGE is a virtual test head emulator that duplicates the performance of the tester hardware. It produces a visual display of the programmed test inputs and actual device outputs as color waveforms, so that programming errors can be quickly spotted and easily corrected.

EFFICIENCY EXPERT.

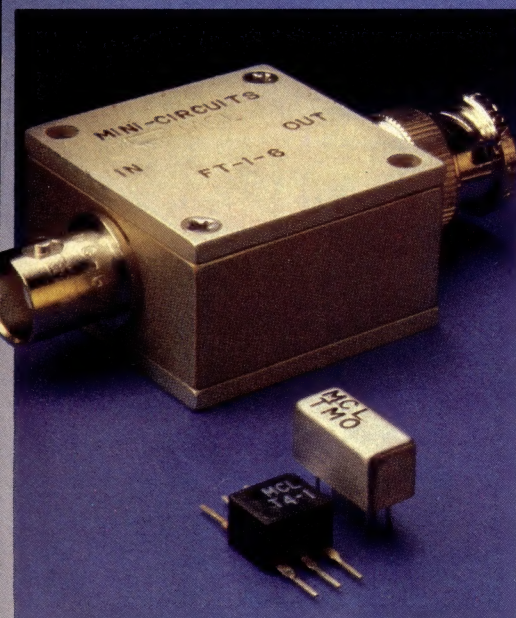
SAGE eliminates juggling scopes and examining reams of pin data printouts to isolate program errors. Once a problem is spotted, the program change can be made and instantly displayed.

And since SAGE simulates responses in the background mode while you're debugging, you don't have to waste valuable tester time to run your program.

For more on SAGE, the higher-level test program development solution that also helps lower your overall cost to test, call or write the ATE software leader: Fairchild Test Systems Group, 1601 Technology Dr., San Jose, CA 95115, (408) 998-0123, Ext. 2296. Fairchild Camera and Instrument Corporation.

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Model No.	TMO1-1		TMO1.5-1	TMO2.5-6	TMO4-6	TMO9-1		TMO16-1	
Imped. Ratio	1	1	1.5	2.5	4	9	9	16	16
Freq. (MHz)	.15-400	8-300	.1-300	.01-100	.02-200	.15-200	2-90	.3-120	7-85
T Model (10-49)	\$2.95	\$4.95	\$3.95	\$3.95	\$3.95	\$3.45	\$5.45	\$3.95	\$5.95
TMO model (10-49)	\$4.95		\$6.75	\$6.45	\$6.45	\$6.45		\$6.45	

CENTER-TAPPED DC ISOLATED PRIMARY & SECONDARY

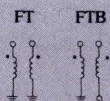


	T1-1T	T2-1T	T2.5-6T	T3-1T	T4-1	T4-1H	T5-1T	T13-1T
Model No.	TMO1-1T	TMO2-1T	TMO2.5-6T	TMO3-1T	TMO4-1		TMO5-1T	TMO13-1T
Imped. Ratio	1	2	2.5	3	4	4	5	13
Freq. (MHz)	.05-200	.07-200	.01-100	.05-250	2-350	8-350	3-300	3-120
T Model (10-49)	\$3.95	\$4.25	\$4.25	\$3.95	\$2.95	\$4.95	\$4.25	\$4.25
TMO model (10-49)	\$6.45	\$6.75	\$6.75	\$6.45	\$4.95		\$6.75	\$6.75

UNBALANCED PRIMARY & SECONDARY



	T2-1	T3-1	T4-2	T8-1	T14-1
Model No.	TMO2-1	TMO3-1	TMO4-2	TMO8-1	TMO14-1
Imped. Ratio	2	3	4	8	14
Freq. (MHz)	.025-600	.5-800	2-600	.15-250	2-150
T model (10-49)	\$3.45	\$4.25	\$3.45	\$3.45	\$4.25
TMO Model (10-49)	\$5.95	\$6.95	\$5.95	\$5.95	\$6.75



	FT1.5-1	FTB1-1	FTB1-6	FTB1-1.75
Model No.				
Imped. Ratio	1.5	1	1	1
Freq. (MHz)	1-400	2-500	.01-200	.5-500
(1-4)	\$29.95	\$29.95	\$29.95	\$29.95



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		Nominal	Tolerance	With Frequency	DC-1000 1000-1500	DC- 1000- 1000 1500	
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AT-6	MAT-6	6	± 0.3 dB	0.6dB	0.8dB	1.3:1	1.5:1
—	MAT-9	9	± 0.3 dB	0.6dB	0.8dB	1.3:1	1.5:1
AT-10	MAT-10	10	± 0.3 dB	0.6dB	0.8dB	1.3:1	1.5:1
—	MAT-12	12	± 0.3 dB	0.6dB	0.8dB	1.3:1	1.5:1
—	MAT-15	15	± 0.3 dB	0.6dB	0.8dB	1.3:1	1.5:1
AT-20	MAT-20	20	± 0.3 dB	0.6dB	0.8dB	1.3:1	1.5:1
AT-40*		40	± 0.3 dB	0.6dB	0.8dB	1.3:1	1.5:1

*AT-40 Frequency Range DC-500 MHz

Frequency Range: DC-1500 MHz, power (max.) MAT = 0.5W, AT = 1W

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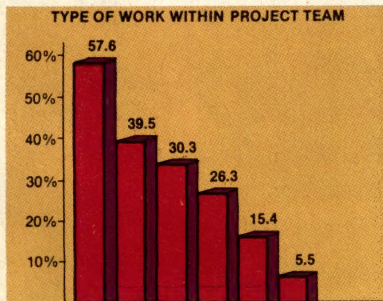
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Maturity needn't be equivalent to stagnation. Although rotary switches have been around for years, the latest introductions have a new look.
- Use comparator ICs in new and useful ways** 115
You can use the unique differential-input/digital-output characteristics of comparators to implement a wide range of circuit functions.
- Built-in overflow detection speeds 16-bit μ P arithmetic** 133
Special programmable hardware in a family of 16-bit processors detects arithmetic overflow automatically, thus allowing shorter and faster arithmetic routines.
- Real-time LSI clock chips ease μ P-control tasks** 138
By providing useful timing outputs compatible with μ P-based systems, multifunction clock ICs help you implement timekeeping with a minimum of hardware and software overhead.
- Technical Article Database** 233
You'll find every major article published in EDN during the past year indexed in our first Technical Article Database, along with coverage for the other major electronics magazines.

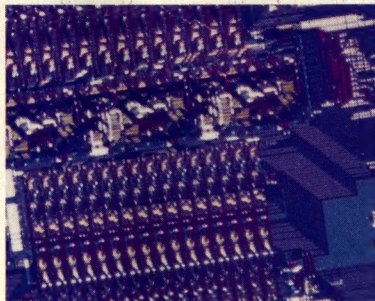
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- What is today's designer like? EDN polls its readers to find out** 79

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A profile of EDN's typical reader contains information that might prove surprising. Learn more about yourself and your colleagues by turning to pg 79.



EDN's first Technical Article Database indexes articles appearing in EDN and four other major electronics publications within the past year (pg 191).



On the cover: today's rotary switches permit clean pc-board design. Turn to pg 98. (Photo courtesy Oak Switch Systems; photographer: Larry Larimer, Business Arts Inc)

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Small, sealed, solderable, and simple.

Three new switches from Oak.

Now you can select a pushbutton or rotary switch perfectly matched to your microprocessor-based application.

Introducing Oak's Series 225 pushbutton switch and Series 500 and 850 rotary switches. Three new products that help cash in on the natural cost and performance advantages of microprocessor control.

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Oak's Series 225 low-profile

pushbutton keyboard switch provides the rugged construction, tactile feel, and quality control so important in hi-rel applications.

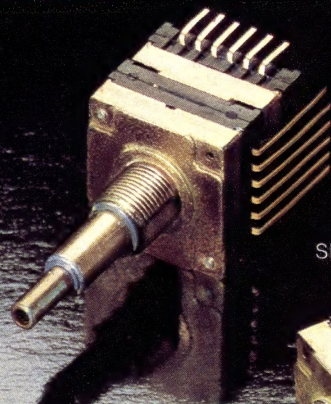
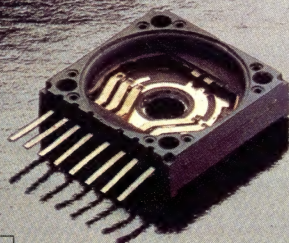
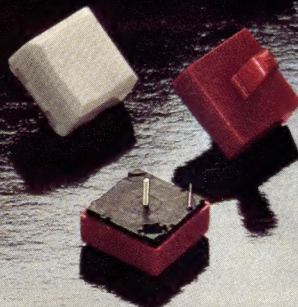
The Series 500, designed to meet the specifications of MIL-S-3786/20, a sturdy single-deck rotary switch just one-half inch in diameter, is ideal for selecting or indicating state of control in portable communications and test equipment.

And our versatile Series 850 programmable rotary switch offers a remarkable choice of switch function, detent angle, and PC board mounting locations in a package only 0.850" square.

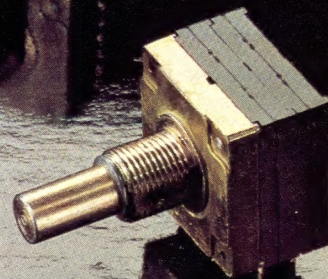
Call or write us today to learn more about three new switches designed with you and microprocessors in mind. You can't afford not to call Oak!



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50
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Floppy-disk-drive sales to rise to \$4.6B in '86... Fault-tolerant computers: \$16.9B market seen in '86.

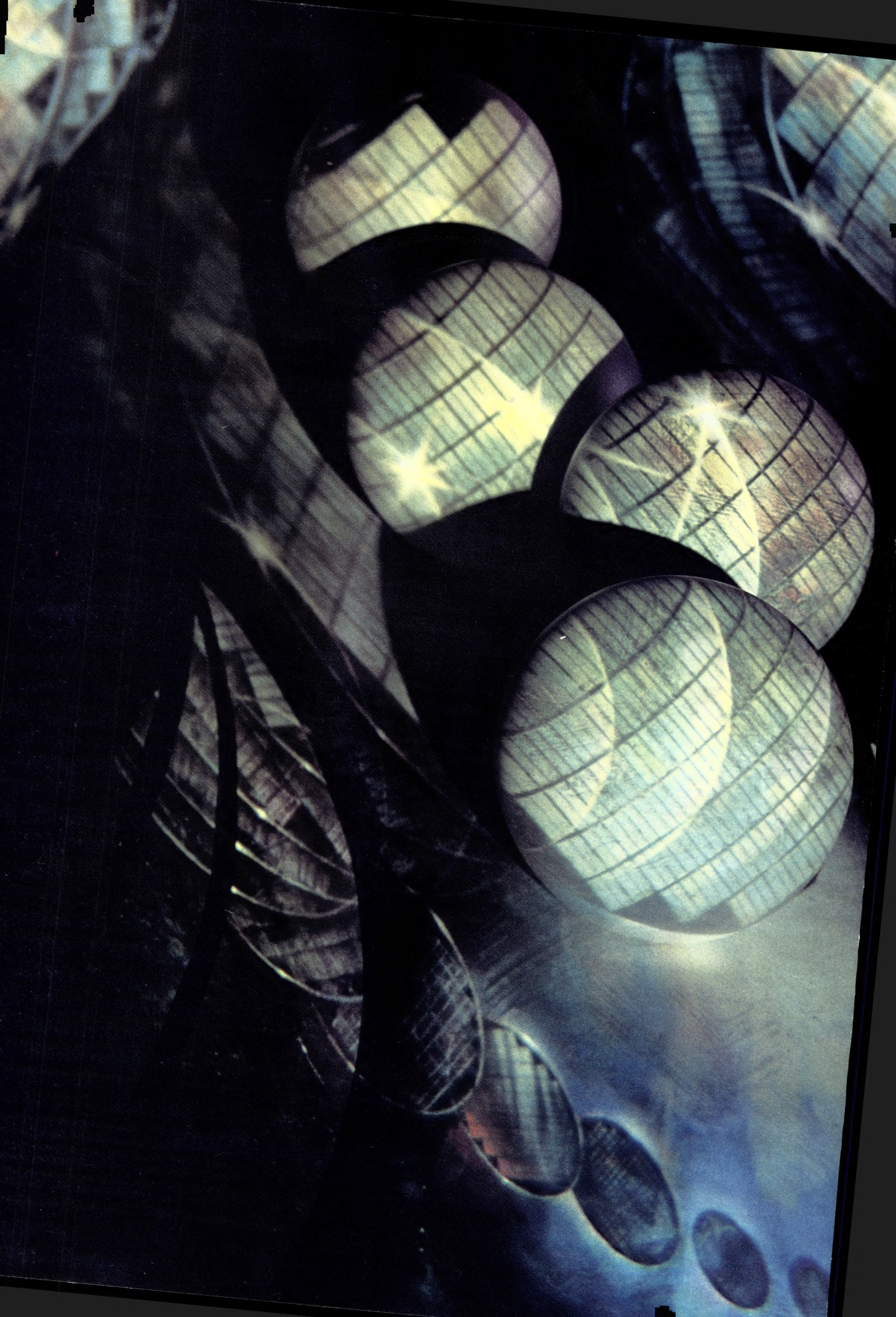
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New 64K DRAM...

"Nibble Mode" gives effective cycle time under 85ns

Here's another first in VLSI from INMOS. It's a 64K x 1 DRAM with a feature called "Nibble Mode". By providing the on-chip equivalent of 4-way interleaving, the IMS2600 allows high-speed serial read/write access to 2 bits, 3 bits or a nibble, allowing effective cycle times below 85 ns.

Two high-speed versions of the IMS2600 are available:

	Access Time	Cycle Time	"Nibble Mode" Cycle Time
IMS2600-10	100ns	160ns	55ns
IMS2600-12	120ns	190ns	65ns

But that's not all. The part operates at cycle times down to 160ns and dissipates only 303mW max at 350ns cycle time (standby power is only 22mW). In addition, this advanced 64K DRAM offers "CAS before RAS," a refresh-assist function that frees pin 1 for future 256K use.

The IMS 2600 is a direct plug-in replacement for other 64K DRAMs in existing designs. And it's the 64K standard for new designs. Available now, the IMS2600 is packaged in a 16-pin, 300-mil DIP with the industry standard pinout.

For a low-cost evaluation kit, "Nibble Mode" application note, or for technical assistance, complete the coupon and mail it today.



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- ☐ Send IMS2600 "Nibble Mode" application note and technical data.
- ☐ Have a salesman call.

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Company _____
Address _____
City _____ State _____ Zip _____
Telephone () _____

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Colorado Springs, CO 80935

EDN 1/6

18

AUGUST
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- * 2.4-5.5 voltage range
- * 84 μ W operating power

21

OCTOBER
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TELECOM PCM
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- * -80dB crosstalk
- * 90dB dynamic range

6

APRIL
1981NSC800
HIGH
PERFORMANCE
P²C MOS
MICROPROCESSOR

- * 50mW at 2.5MHz
- * -55°C to +125°C operation
- * Z80[®] instruction set

1

JUNE
1981NMC27C16
P²C MOS
EPROM

- * 350ns access time
- * 10mA active current (max)
- * 25 μ A standby current (max)

12

APRIL
1982

CIM802

P²C MOS
CPU BOARD

- * Full family of CMOS boards
- * Based on NSC800, NSC810, NMC27C16
- * -40°C to +85°C operation

15

APRIL
1982SCX6324
M²C MOSTM
GATE ARRAYS

- * 2400 gates
- * 3 μ gate feature size
- * 2ns internal t_{pd}

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Motorola, Inc.

17

SEPTEMBER
1982A/D AND D/A
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- * 10,000,000th CMOS data converter shipped

6

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74HC
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- * $\pm$ 4mA output -10 LS loads
- * Extended supply range

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26

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1981

MF10

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CAPACITOR
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* General purpose,
dual active

* No tuning
required

* HP, BP, LP, AP and
NOTCH

6

OCTOBER
1982

MA2800

P²CMOS
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microcomputer
system

* Based on NSC 800,
NSC 810, NMC 27C32

* Package size -
3.3" x 1.6" x 0.45"

At National Semiconductor, we're applying advanced CMOS technology to more of the products you need to solve your design problems than anyone else.

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CIRCLE NO 20

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EVERYONE
SHOULD KNOW
HIS PLACE.**

OURS IS SUPPOSED TO BE SECOND.



BUT ROCKWELL'S NEW PERIPHERALS GIVE YOU EVERYTHING THE 68000 PROMISED. FIRST.



Breakthroughs in 16-bit technology aren't supposed to be our job. But we keep winning blue ribbons. So with as little fanfare as possible, we are introducing three firsts in 68000 peripherals: the Multi-Protocol Communications Controller (MPCC); the Double-Density Floppy Disk Controller (DDFDC); and the Local Area Network Controller (LANC). All three are uniquely designed to extend your system's performance.

Our new R68561 MPCC is the first 16-bit bus 68000 peripheral to provide full-up data link communications on a single chip. At 4 megabits/sec, it's the fastest communications controller you can buy. It's also the most versatile, supporting all standard asynchronous and synchronous protocols—and BISYNC and HDLC especially well. Then there's extensive on-board buffering, vectored interrupts, automatic address recognition, and a DMAC interface compatible with the 68440 or 68450 DMAC devices.

The R68465 Floppy Disk Controller is another example of engineering beyond our means. It's the first full-featured device for the 68000 that's designed especially for floppy disk control, and does its job more efficiently than the peripherals that try to control both hard disks and floppies. The R68465 serves four double-density drives, in either MFM or FM IBM-compatible formats.



Samples of both peripherals are available now from your Rockwell representative or distributor. Soon he'll be stocking another of our missteps up the ladder of success: the R68802. It's the first Local Area Network controller for the 68000. Because it provides all basic logical data link control functions, the Rockwell controller is a more flexible, more cost-effective solution for 10 megabit/sec LAN data rates. The R68802 supports both the IEEE-802 and the Ethernet* standards on the proven CSMA/CD bus access method, plus statistical function—features not available on any other LAN controller. Versions that are compatible with 8-bit bus architecture are also available.



Up until now, being first in peripherals hasn't been our goal in life. But don't be surprised if this taste of success goes to our head, and we come out with more winning 68000 peripherals in the near future.

To get your samples of the MPCC and Floppy Disk Controller, and keep up with the latest in 68000 peripherals, contact your Rockwell representative or distributor, or call the Electronic Devices Division, Rockwell International, at (800) 854-8099. In California, call (800) 422-4230. Or write us at P.O. Box C, MS 501-300, Newport Beach, CA, 92660. * Ethernet is a trademark of Xerox.



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Narrator offers these Allophone

options: a single chip with your own enhancements...or a self-contained, economical module, the VSM2128, which needs only a power source and speaker. The SP0256-AL2 chip has a low bit rate and interfaces easily with today's microprocessors. We also provide a full line of add-on memory circuits, including 16, 32 and 128K serial speech ROMs, and the logic interface chips to expand processing power.

Easy to Program

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News Breaks

REAL-TIME UNIX FOR IBM PC AIMED AT OEM MARKET

A licensed version of System III UNIX with enhancements for real-time operation on the IBM Personal Computer will soon be available to OEMs for less than \$500. Named VENIX, the software comes from Venturcom (Cambridge, MA) and includes additional commercial programs such as word processing, graphics and a relational database manager. The company also plans to offer scientific and engineering software, including a signal-processing package. First deliveries will be in March.—Gary Legg

MICROFLOPPY INTROS MUDDLE STANDARDIZATION EFFORTS

The attempt to establish a standard for sub-4-in. floppy-disk drives has become more confused as vendors continue to introduce incompatible designs. For instance, Tandon Corp (Chatsworth, CA), having already announced two 3¼-in. drives, is rumored to also be planning a 3¼-in. entry, compatible with the flexible-jacketed Dysan media. Meanwhile, MPI (Chatsworth, CA) has introduced Model 301F—a microfloppy that uses the Japanese 3-in. media. In this unit, a user can flip the diskette over to store 250k bytes on each side. Priced at \$200 (1000), the drive will be available in small quantities (100) this month.—Ed Teja

DATAComm SIMULATOR IMITATES TERMINAL OR NETWORK

The Chameleon from Tekelec Inc (Santa Monica, CA) is a 35-lb datacomm simulator that looks like a personal computer. When you plug in one of four software packages in its dual 3¼-in. Sony floppy drives, the \$18,000 unit functions as a terminal, cluster controller, front-end processor or network, using any protocol (including X.25, SNA, SCLC, HDLC and Bisync) at speeds to 128k bps. The instrument collects and analyzes data after trigger actuation at the link level or higher and outputs industry mnemonics or binary, hex or ASCII code on a 9-in., 80-line x 24-character screen. Tekelec has also announced its \$2200 Model P.1, a Multibus-compatible board that automatically handles all link-layer operations for SDLC or HDLC; it adds or strips off protocol data so your system deals only with a transmission's information layer. This board also offers full error-recovery procedures.—Paul G Schreier

DEVELOPMENT SYSTEM ENHANCES MICROCODE-DESIGNER PRODUCTIVITY

By adding several ease-of-use features to its Step-10 development system, Step Engineering (Sunnyvale, CA) has produced the Stepsaver—a microcode development system designed to improve engineer productivity. Features include a macro-command queue to store and label complete macros, a machine-state-save feature to save and store complex setups (as many as 32,000 separate entries), and four Help files, which can be customized for specific applications. Prices range from \$20,500 to \$60,000.—Gary Chesnutis

MACHINE-INSERTABLE DIP SWITCHES SPEED BOARD ASSEMBLY

With ratings of 50 mA at 30V dc, Series 90 machine-insertable DIP switches from Grayhill Inc (La Grange, IL) come with two through 10 or 12 stations. The plastic-packaged devices are less than 0.180 in. high and thus suit automatic insertion. The 8-station version is as long as a standard 16-pin DIP. The devices are undergoing testing with users and IC-insertion-equipment manufacturers; production is scheduled for February.—Paul G Schreier

ISSCC: SEMICONDUCTOR LEADERS TO DISCUSS JOINT R&D EFFORTS...

With the 30th annual International Solid-State Circuits Conference (ISSCC) as a backdrop, prominent US semiconductor-industry leaders will focus on the important and timely issue of joint R&D efforts during one of the conference's evening sessions. According to ISSCC program chairman Lewis M Terman of IBM's Research Center (Yorktown Heights, NY), no

News Breaks

other sessions have been planned for that evening in anticipation of a large turnout.

The session's panelists include Dr Richard D DeLauer, Under Secretary of Defense for Research and Engineering; Gordon Moore, president of Intel Corp; W J Sanders, president of Advanced Micro Devices; Eric Bloch, IBM VP for technical activities; J W Lacey, technology-planning executive VP of Control Data Corp; James Meindl, director of Stanford University's Electronics Laboratory; and George Pake, Xerox VP for corporate research.

The discussion will address whether joint R&D efforts actually enhance innovation and reduce competition; the cost; how patents and proprietary information can be handled; and at what technology level a joint effort should be used. The panelists will also discuss whether a joint R&D venture will return the US to a leadership position in technology.—John Tsantes

...WHILE TECHNICAL SESSIONS WILL FOCUS ON DEVICE TECHNOLOGY

ISSCC 83, to be held on February 23 to 25 at New York City's Sheraton Centre hotel, will once again set the stage for attendees to get a glance at international device technology and research. During the 18 daytime technical sessions, an impressive list of papers authored by more than 300 technologists will cover such topics as telecomm circuits, high-speed microprocessors, GaAs ICs, VLSI memories, speech recognition and gate-array logic.

A few of the devices to be discussed include a 16-bit microprogrammable μ P that can simulate various computers at 900k instructions/sec max; GaAs 32-bit adders and 1k static RAMs; a 5000-gate bipolar master slice with 500-psec loaded gate delay; a 200-nsec, 256k EPROM; several 5V-only 32k EEPROMs; an 8-bit, 50-nsec A/D converter with internal sample/hold; and sub-100-nsec 256k dynamic RAMs.

For additional information on ISSCC, contact Lewis Winner, 301 Almeria, Coral Gables, FL 33134, or phone (305) 446-8193 between 1 and 5 pm.—John Tsantes

COMDEX FALL '82—WHAT YOU MIGHT HAVE MISSED

If you didn't get a chance to attend Comdex Fall '82 in Las Vegas last month, you missed many new-product offerings and demonstrations. Therefore, browse through these brief capsules for products that might be of particular interest to you.

...Applied Digital Data Systems's (Hauppauge, NY) \$995 (100) Viewpoint/Color CRT terminal displays 25 80-character lines and exhibits eight colors. Ergonomic features include a tilt-and-swivel screen and a DIN-standard low-profile keyboard.

...Built around the Arcnet and Ethernet local networks, the PLAN 4000 system from Nestar Systems (Palo Alto, CA) interconnects the IBM, Apple II and Apple III personal computers via a \$595 network interface card. It supports a mix of 255 workstations and servers (costing about \$1800 each), 548M bytes of disk storage, 20M or 45M bytes of tape capacity and a 2.5M-bps data rate using baseband and token-passing protocols.

...The \$7160 DCG03 disk controller from Plessey Peripheral Systems (Irvine, CA) handles as many as four physical or eight logical 14-in. Winchester disk drives, providing as much as 2G bytes of storage. It also controls drives that emulate DEC's RM03, RM05 and RM80 units in any combination of capacities.

...DMA Systems Corp (Goleta, CA) previewed the Micro-Magnum 5/10 and 5/15 5¼-in. Winchesters, slated for introduction in the 2nd and 3rd quarters, respectively. They'll come with 13.0M- and 19.5M-byte capacities on fixed disk and 6.5M bytes of removable cartridges. The 5/10 will sell for \$1390; the 5/15, \$1450; the removable cartridge, \$85 (OEM qty).

...CP/M originator Digital Research (Pacific Grove, CA) announced several intercompany agreements: Advanced Logic Systems (Sunnyvale, CA) will manufacture a \$399 CP/M card



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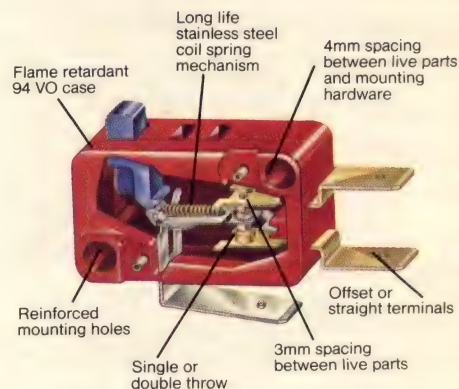
CEE, BSI, SEMKO, BEAB and SEV. The solid, reinforced mounting boss gives the added protection of increased spacing between "live" parts and mounting hardware. Choice of U.S. (#4 screws) or metric (3 mm screws) mounting holes.

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CIRCLE NO 23

News Breaks

with CP/M Plus for Apple II and Apple II+ computers; Otrona Corp (Boulder, CO) will extend the CP/M operating system with its GSX graphics system on the Attache 8-bit portable computer; Xerox Office Products Div (Dallas, TX) has licensed all Digital Research software products for developing applications that will run on the Xerox 820-II personal computer; Byad Inc (Chicago, IL) sold its rights for the CP/M card, which allows the 16-bit IBM Personal Computer to use the 8-bit CP/M operating system; Percom Data Corp (Dallas, TX) will distribute the PC Power Pack, consisting of a 5M- to 30M-byte 5¼-in. Winchester disk drive, a 256k-byte RAM board and controller and the Concurrent CP/M-86 operating system for the IBM PC. New software products from Digital Research include CP/Net Version 1.2, which extends CP/M power into a networked environment without modification to the operating system's existing disk, console and printer drivers; a \$500 GSS-4010 interactive utility, which allows CP/M-based μ Cs to emulate the Tektronix 4010 graphics terminals; a \$500 GSS-Kernal programming tool, which provides a subroutine library of 2-dimensional graphics primitives that integrate graphics functions into application packages; and the \$500 GSS-Plot subroutine library, which produces high-level graphics functions for producing bar and line graphs, pie charts, histograms and scatter plots.

...With prices starting at \$16,000, Spirit and Factor Series 16-bit multiuser μ Cs from Victory Computer Systems (San Jose, CA) feature an iAPX 186 or 68000 main processor, two Z80 distributed- and I/O-control μ Ps, a Z8002 disk-control μ P, 120M bytes of fixed-disk memory, 6M bytes of removable-disk storage, 1M bytes of floppy-disk capacity, and CP/M-86, MP/M-86 and CP/M-80 operating systems for as many as 32 users.

...The Multibus-compatible Series 1600 computer systems from Datamac (Sunnyvale, CA) come with a Z80A and either an 8086 or 68000 processor. In Z80A mode, the \$3300 to \$8000 systems support CP/M-2.2, MP/M-II, CP/M-86 and MDOS; in 8086 mode, CP/M-86, MP/M-86, and MS-DOS; in 68000 mode, UNIX and OASIS. They employ an 83-key detachable keyboard; a 12-in. 80×26-formatted video monitor; any combination of four 5¼-in. floppy- or hard-disk drives for a total storage capacity of 160M bytes; and as much as 2M bytes of main memory.

...Data Impact Products Inc (Boston, MA) supplies a \$395 multifunction IBM Personal Computer memory-expansion card. On-board features include 64k to 256k bytes of dynamic RAM, a battery-driven clock/calendar, a software-programmable half- or full-duplex RS-232C port and a Centronics-compatible printer port.

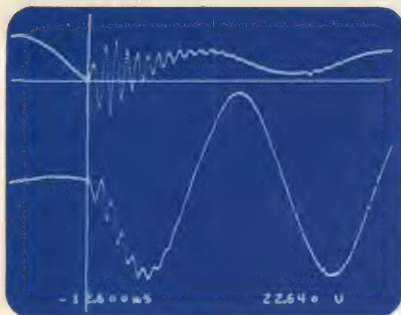
...Accommodating five to eight users for less than \$5000, the Altos 586 16-bit μ Cs from Altos Computer Systems (San Jose, CA) support Ethernet and Altos-Net networking for as many as 200 workstations and peripherals. They incorporate the 10-MHz 8086 μ P; 256k to 1M bytes of RAM; XENIX, UNIX, MS-DOS, PICK, CP/M-86, MP/M-86 and OASIS operating systems; and as much as 20M bytes of hard- and floppy-disk storage.

...Aimed for use with TK!Solver software, TK!SolverPacks from Software Arts Inc (Wellesley, MA) solve common electrical-engineering and units-of-measure problems. These packages include complex circuit- and filter-design equations and models, as well as measurement-conversion factors.

...Bringing word processors a step closer to the mass market, C Itoh Electronics Inc's (Los Angeles, CA) Model A-10 daisywheel printer prints at 18 cps and comes with either an RS-232C or parallel interface. You can choose friction or bidirectional tractor feed. The unit costs approximately \$995.

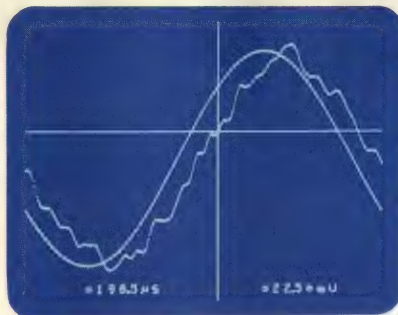
...Making CP/M-based 16-bit computers more accessible to nontechnical operators is the purpose of CP+. The \$200 software package, from Taurus Software Corp (Lafayette, CA), translates terse system commands into English. You select basic system operations from a menu.—George Kotelly, Ed Teja

Compare.



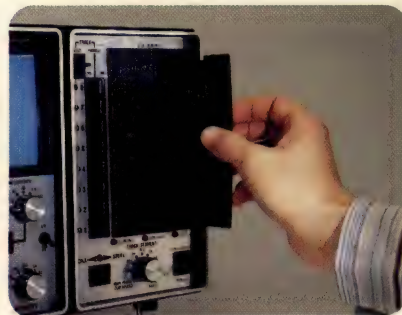
Realtime Monitoring and Storage.

Nicolet Oscilloscopes can monitor, capture, and store signals with both pre- and post-trigger information.



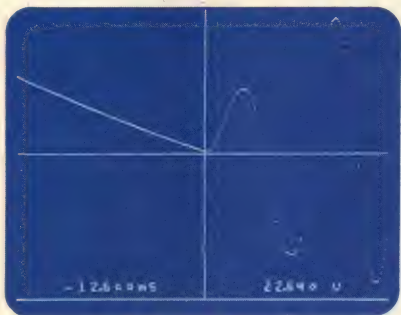
Waveform Comparison.

Nicolet Oscilloscopes can display a live or stored signal with a previously stored reference or a second signal.



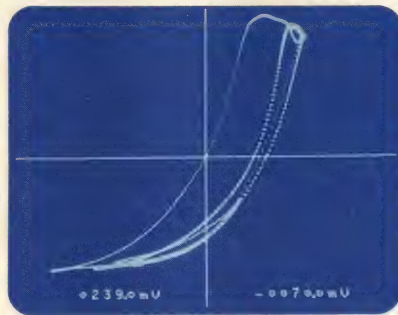
Permanent Storage and Hardcopy Records.

Nicolet Oscilloscopes can store waveforms permanently on a built-in floppy disk for later recall and/or output to an external plotter.



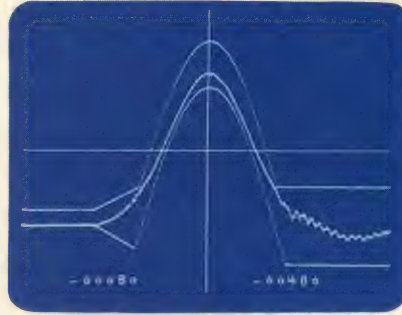
Expansion, Resolution and Accuracy.

Nicolet Oscilloscopes can expand any selected feature up to X256 with resolution up to 0.002% and accuracy as high as 0.2%.



X/Y Display.

Nicolet Oscilloscopes can display a waveform as a function of another, either in live or stored mode.

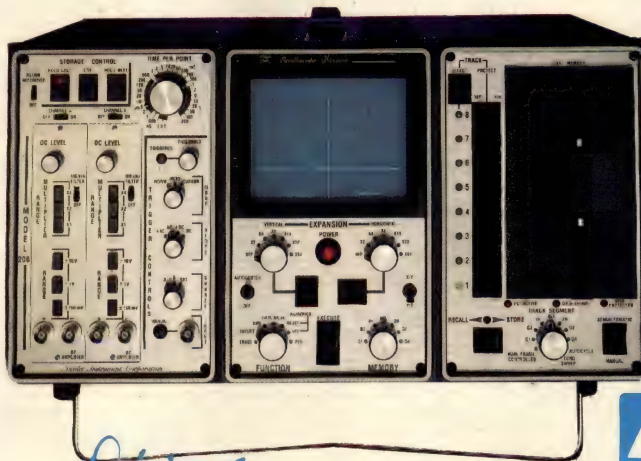


Digital Interfaces.

Nicolet Oscilloscopes can interact with computers or calculators. (In this case, comparing a live waveform to computer-drawn limits.)

Compare these features with any other oscilloscope.

The choice should be obvious.



For more information on the 2090 Series or the more powerful 4094, call 608/271-3333. Or write Nicolet Instrument Corporation, Oscilloscope Division, 5225 Verona Road, Madison, Wisconsin 53711.



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OPTICAL DISK RECORDS ANALOG AND DIGITAL INFORMATION

Sony Corp's prototype optical-disk system employs a nonerasable 30-cm disk that stores digital signals equivalent to 20,000 12 x 8-in. pages of text or analog signals equivalent to 25 min of color-TV programs. The acryl-based disk's dual-layer structure consists of a recording layer of antimony/selenium alloy and a heat-absorbing layer of bismuth/tellurium. Unlike other laser-based techniques, which produce pits in a vapor-deposited surface, Sony's recording method uses the change in state from amorphous to crystalline that occurs in a thin film when heat is applied by a laser. Because of the recording layer's amplification effect, only a 6- to 7-mW laser-diode output is needed. Commercial models will be introduced next January.—Shelley Mumford

1k GaAs MEMORY CHIP ACCESSES IN 3.7 NSEC

Nippon Telegraph and Telephone Corp's 1k-bit semiconductor-memory prototype uses a GaAs chip, spec'ing a 3.7-nsec access time that the firm says can be improved to 1.4 nsec. The 3.32 x 3.32-mm chip integrates 7084 FETs. The firm is undecided about commercial plans for the memory.—Shelley Mumford

16k ECL RAM CUTS ACCESS TIME BY FOUR

Hitachi Ltd claims that its 16k-bit ECL dynamic RAM is four times faster than available 64k RAMs. Scheduled for use in the firm's super-computer systems, it specs a 25-nsec access time. Using a 5.36 x 3.05-mm chip, the device requires 750 mW and employs 2- μ m design rules. Production is scheduled to start in March; samples are available for 30,000 yen (\$113).—Shelley Mumford

16-BIT DIGITAL PROCESSOR EXECUTES COMMANDS IN 250 NSEC

Designed for use in voice-analysis, voice-recognition and mobile-telephone systems, Hitachi Ltd's HD61810 16-bit single-chip digital signal processor specs a 250-nsec command-execution time. The CMOS device incorporates a 16-bit multiplier and features 250-mW dissipation. It also includes an adder-subtractor and 16-bit A/D and D/A interface circuits. Prices start at 12,000 yen (\$45.30) (5000)—Shelley Mumford

SLIMLINE 16k PROMs REDUCE PACKAGING FOOTPRINT

Housed in 300-mil-wide DIPs, Fujitsu Ltd's MB7137-SK, 7138-SK, 7133 and 7134 spec 45- or 55-nsec access times. Using 32k-PROM processing technology, the firm reduced by 20 to 30% the memory-devices' cell and chip surface areas. The 45-nsec version costs 2000 yen (\$7.40); 55-nsec devices, \$6.30 (1000).—Shelley Mumford

DUAL-PROCESSOR PERSONAL COMPUTER RUNS 8-, 16-BIT SOFTWARE

Fujitsu Ltd's 16-bit FM-11 incorporates 8088 and 6809 μ Ps and supports both CP/M-86 and MS-DOS operating systems. It employs an optional Z80-based card to run 8-bit software. Priced between 268,000 and 398,000 yen (\$993 to \$1474), the computer features a 128k-byte main memory, expandable to 1M bytes. Delivery starts this month.—Shelley Mumford

IC-PROCESSING ROBOTS SLATED FOR US PLANT

Ideya, an Osaka-based robotics-systems manufacturer, will produce three unmanned processing lines for Motorola Inc's ICs. Replacing three to five workers, each line solders the leads, then washes, dries and inserts the IC packages into pallets. Selling for 30M yen (\$111,000), each system consists of a turntable-like automatic soldering system, a rotary cleaning and drying machine, and a pallet feeder controlled by an 8-bit μ C. Military-spec revisions requiring that all ICs have soldered leads has heightened US interest in the product.—Shelley Mumford

How To Put 3 Volts At Your Fingertips



Lithium Power... Three Volts in Less Space

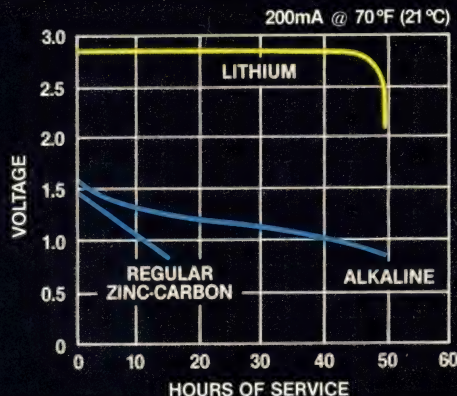
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A MISTAKE.**



SOMEHOW, THE R6500/* HAS BECOME THE TOP 9 MICROCOMPUTERS.

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His first mistake was making the R6500/1 the benchmark champ¹ among 8-bit microcomputers. We've compounded that mistake by coming up with four more R6500/*'s with more features, the same high performance and up to 56 I/O lines.

And we've continued to break the rules. Now, Rockwell International is forced to introduce four more members of the R6500/* family. Designed for use in multiple-CPU systems, the new R6500/41, /42, and /43 and R6541Q Intelligent Peripheral Controllers let you off-load control tasks from your central CPU. The necessary intelligence is downloaded into RAM through a special asynchronous host bus port, compatible with R6500, Z80, 8080, and 6800 bus structures.

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Rockwell never intended to be recognized as the Top 9, the Top 5, or even the Top 1. It hasn't been our style, but you can profit from our mistake by benchmarking the R6500's in your application.

Contact your local Rockwell distributor or Sales representative, or the

Models	New R6541Q	New R6500/41 IPC	New R6500/42 IPC	New R6500/43 IPC	R6511Q	R6500/11	R6500/12	R6500/13	R6500/1
ROM (x8)	—	1536	1536	256	—	3072	3072	256	2048
RAM (x8)	64	64	64	64	192	192	192	192	64
I/O Lines	23	23	47	23	32	32	56	32	32
Serial Comm.	—	—	—	—	UART	UART	UART	UART	—
Counters	1x16	1x16	1x16	1x16	2x16	2x16	2x16	2x16	1x16
Expansion Bus	8K	4K	4K	4K	65K	16K	16K	65K	—
Interrupts	5	4	4	5	6	6	6	6	3
External	1	1	1	1	4	4	4	4	1
Internal	2	2	2	2	—	—	—	—	—
Host	—	—	—	—	—	—	—	—	—
Standby RAM	—	—	—	—	12	12	12	12	35
Package	64-pin QUIP	40-pin DIP	64-pin QUIP	64-pin QUIP	64-pin QUIP	40-pin DIP	64-pin QUIP	64-pin QUIP	40-pin DIP

Electronic Devices Division, Rockwell International, at (800) 854-8099. In California, call (800) 422-4230. Or write us at P.O. Box C, MS 501-300 Newport Beach, CA 92660.

1. Benchmark test specified by Texas Instruments, including TMS7000, Z8, 8051 and R6500/1. Details provided on request.

2. Source: Dataquest



Rockwell International

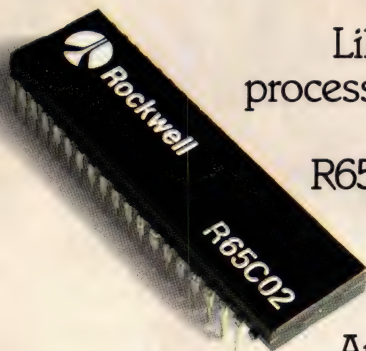
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WHO EXPECT
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ROCKWELL'S NEW HIGH PERFORMANCE CMOS FAMILY MAY RUIN OUR REPUTATION.



Like our NMOS 8-bit family, our CMOS microprocessors seem to out-perform the competition's.

We're reluctant to admit that the 4MHz R65C02 is one of the first microprocessors, CMOS or NMOS, that can execute an instruction in half a microsecond. That its 2MHz version consumes only 40mW — 1/20 the power of the NMOS version. And that it is pin-compatible with the R6502.

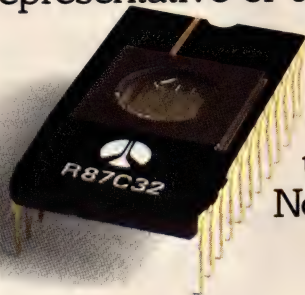
We've also added 12 new instructions to the R65C02 set.

As long as we're clearing our conscience, let's also admit that the R65C02 is only one of our new CMOS designs. There's also the R65C102, a microprocessor with on-chip oscillator, and the slave processor R65C112, which accepts an external clock input. The R65C21 Peripheral Interface Adaptor that drives two TTL loads at once and the R65C24, with all the capabilities of the R65C21, plus a 16-bit counter/timer with latch.

There's also the R65C51 Asynchronous Communications Interface Adaptor. And these new CMOS RAMs and ROMs to choose from: 16K Static RAM, 32K EPROM, 64K EPROM, and 64K ROM.

And Rockwell supports system development for all Rockwell CMOS and NMOS microprocessors through SYSTEM 65 and the new Rockwell Design Center (RDC).

We can't blame you for expecting less of us. For years, we've been trying hard not to be recognized as Number One. But you can profit from our slip-up by trying these new CMOS parts in your application. We'll apologize in advance for providing you with higher performance and lower power consumption. For information, just contact your nearest Rockwell sales representative or distributor or the Electronic Devices



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SOMEBODY BROKE IT.



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Our rule was already broken when we came up with the 10937, the first single-chip controller for alphanumeric displays. Now the offense has been repeated not once, but five times, to give Rockwell the leading family of intelligent controllers that directly drive VF displays of up to 60 volts.

Our new 10938, 10941, 10942, and 10943 anode drivers simplify your design job for all sizes of alphanumeric displays, from 8 character segmented to 80 character 5x12 dot matrix. All four, and the companion 10939 grid driver, accept either serial or parallel I/O. Because all of these devices have built-in intelligence, they lower your hardware costs by as much as 30¢ per character. If your product has an 80 character display, our controllers save you \$24.

Besides eliminating TTL parts, Rockwell's intelligent display drivers reduce the load on your CPU by 90%, because they handle the complete display refresh function.

It's bad enough having these advanced parts for VF displays, but it doesn't stop there. All 6 work with any host processor with just 2 I/O pins through a serial interface.

We've been reluctant to talk about our leadership in display controllers. On the other hand, our distributors are loaded up with them and will be more than happy to talk about filling your order today. Check the chart to get an idea of the best combination for your application, then contact your nearest Rockwell distributor. Or the Electronic Devices Division, Rockwell International, at (800) 854-8099. In California, call (800) 422-4230. Or write us at P.O. Box C, MS 501-300, Newport Beach, CA 92660.

GUIDE TO CHOOSING ROCKWELL DISPLAY CONTROLLERS

Display Type		Anode Drivers	10939 Grid Driver
Characters	Segments/ Matrix		
8	14-18	A single 10937 device provides anode and grid drivers for these display types.	
10	14-18		
16	14-18		
20	14-16	1 (10941)*	1
32	14-16	1 (10941)*	2
40	14-16	1 (10941)*	2
20	5x7	1 (10938)	1
32	5x7	1 (10938)	2
40	5x7	1 (10938)	2
40	5x12	1 each (10942 & 43)	2
80	5x7	1 (10938)	4
80	5x12	1 each (10942 & 43)	4

*Also controls bar graph function.



Rockwell International

...where science gets down to business

CIRCLE NO 27

Signals & Noise

Updating CAD tapes can prove troublesome

Dear Editor:

Your article on CAD services (EDN, November 10, pg 119) provides useful details but fails to address a very important topic: design portability. I had some pc boards designed on a Computervision CADD3 system, then brought the tapes with me when I moved to the East Coast. I had difficulty locating a CAD service vendor in the New Jersey area capable of updating my designs—one with hardware and software compatible with my tapes.

The local Computervision office found one firm that could provide services—a 2-hr drive away in Philadelphia. There I learned that my tapes are

incomplete because they lack a library. To overcome this obstacle, I had to supply negatives of the version to be updated. After



"WE'VE BEEN BOUNCING
SIGNALS OFF OF
WHAT POLE?"

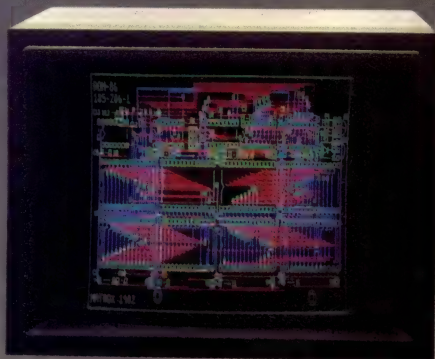
about 6 wks of correspondence and unanswered phone calls to the company, I finally obtained a quote by writing to the firm's president. And what a quote it was—about five times as expensive as redesigning the boards.

The moral is that you must be careful when selecting a CAD service vendor, for if you must change vendors, you'll probably have to redo much of your work. For example, I was told that my CADD3 tapes wouldn't play on the newer CADD4.

If I had it to do all over again, I wouldn't use CAD services, in which your hands are tied by the vendor. If you have artwork, however, you're in the driver's seat: Almost anyone can update conventional artwork; very few

Continued on pg 32

COLOR GRAPHICS BOARDS



MATROX GXB-1000 - The complete color graphics solution.

The GXB-1000 is a complete color graphics display system implemented on two Multibus boards. The system executes a display file containing high level graphics commands, generated by the user's host CPU. The GXB-1000 includes all the necessary hardware and software to draw lines, polygons, circles, characters, etc.

The unmatched performance and low cost of GXB-1000 make it the perfect solution for OEM color graphic displays. Additionally, Matrox can provide RGB monitors, CPU boards, memory boards, cardcages and keyboards for complete display system requirements.

Multibus - TM Intel, *QTY 100

1024 X 1024

DISPLAY RESOLUTION: 1024 x 768 pixels non-interlaced at 60Hz or up to 1600 x 1200 pixels interlaced at 30Hz

READ/WRITE AREA: 1024 x 1024 x 4 bits/pixel expandable to 1024 x 1024 x 16 or 2048 x 2048 x 4

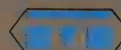
SPEED: Four on-board processors draw graphics primitives at 50 to 800 nsec/pixel

COLOR: 16 display colors from a palette of 256

SOFTWARE: On-board 16 bit CPU with resident graphics software interprets over 256 commands

MODULARITY: GXB-1000 is fully Multibus compatible (IEEE-796), and requires only + 5V

PRICE: \$3225.00 complete*

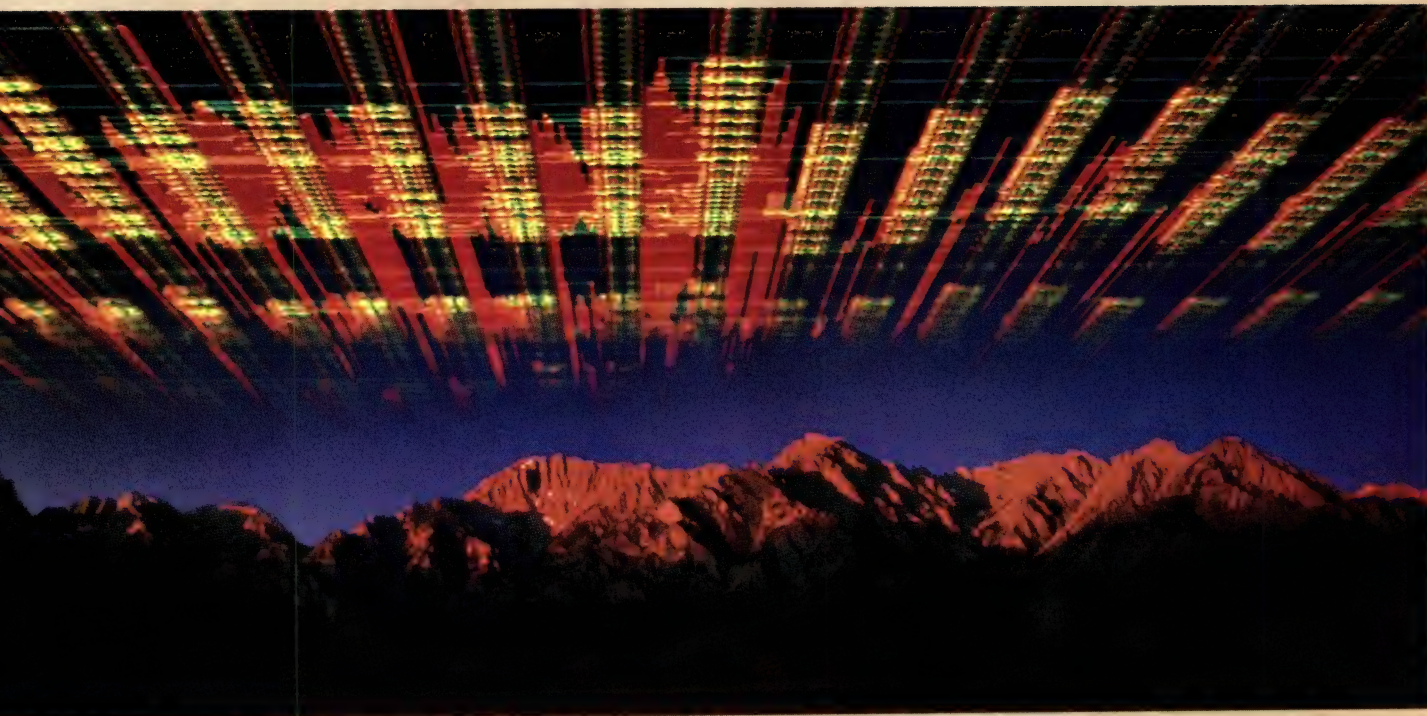


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CIRCLE NO 29

**For the microcomputer software engineer who
doesn't have time to make mistakes.**



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Conventional Pascal has supported only certain phases of microcomputer software design.

Until now.

Tek goes all the way with the Pascal Language Development System (LANDS) for the 8560 Multi-User Development System.

A Language-Directed Editor cuts time recompiling.

The Pascal Language-Directed Editor catches and flags syntax errors before they ever reach the compiler.

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Signals & Noise

companies can update computer tape. I'd rather hand-tape boards than be at the mercy of a CAD service vendor.

Sincerely,

E W Rummel

Technical Director

Robin Baker Associates Inc

Short Hills, NJ 07078

(Ed Note: It's unfortunate that engineers' first experiences with new technologies often prove disappointing. Because new processes and design methods frequently entail user-interface, standardization and customer-support problems that require continual product and service evolution, even the use of

seemingly mature technologies—such as CAD for pc layout—can tax an engineer's patience and resources. Thus, designers like Mr Rummel who are quick to employ new devices and techniques sometimes must pay a high price for innovation.

(However, you should keep such problems and expenses in perspective when weighing a new technology's advantages against its potential pitfalls. Frequently, the cost and time required to learn new design methods and modify your designs as the technology evolves are justified by the benefits that such techniques offer. CAD, for example, often results in faster design cycles that speed products to market and instill designs with significant competitive advantages. Thus, users can recover the investments required to adapt to and overcome a technology's early limitations. And even if you've decided that a technology's disadvantages overshadow its benefits, remember that the situation is likely to change; equipment manufacturers and service bureaus constantly strive to enhance the accessibility of products and services.

(Thanks to such efforts, several options now exist for CAD users like Mr Rummel who possess databases that are incompatible with local service bureaus' equipment. For example, Octal Inc (Mt View, CA) offers a CAD-database conversion service; the firm translates design data to and from several formats—including those of Applicon, Computervision and Calma—for fees that depend on database size and conversion complexity. Octal can complete translations in 48 hrs.

(To provide a more fundamental solution to the database-

Continued on pg 36

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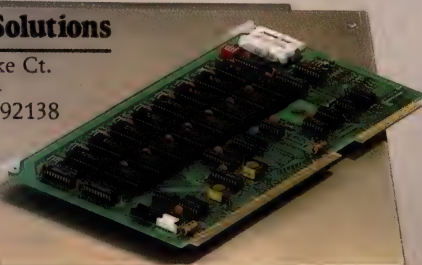
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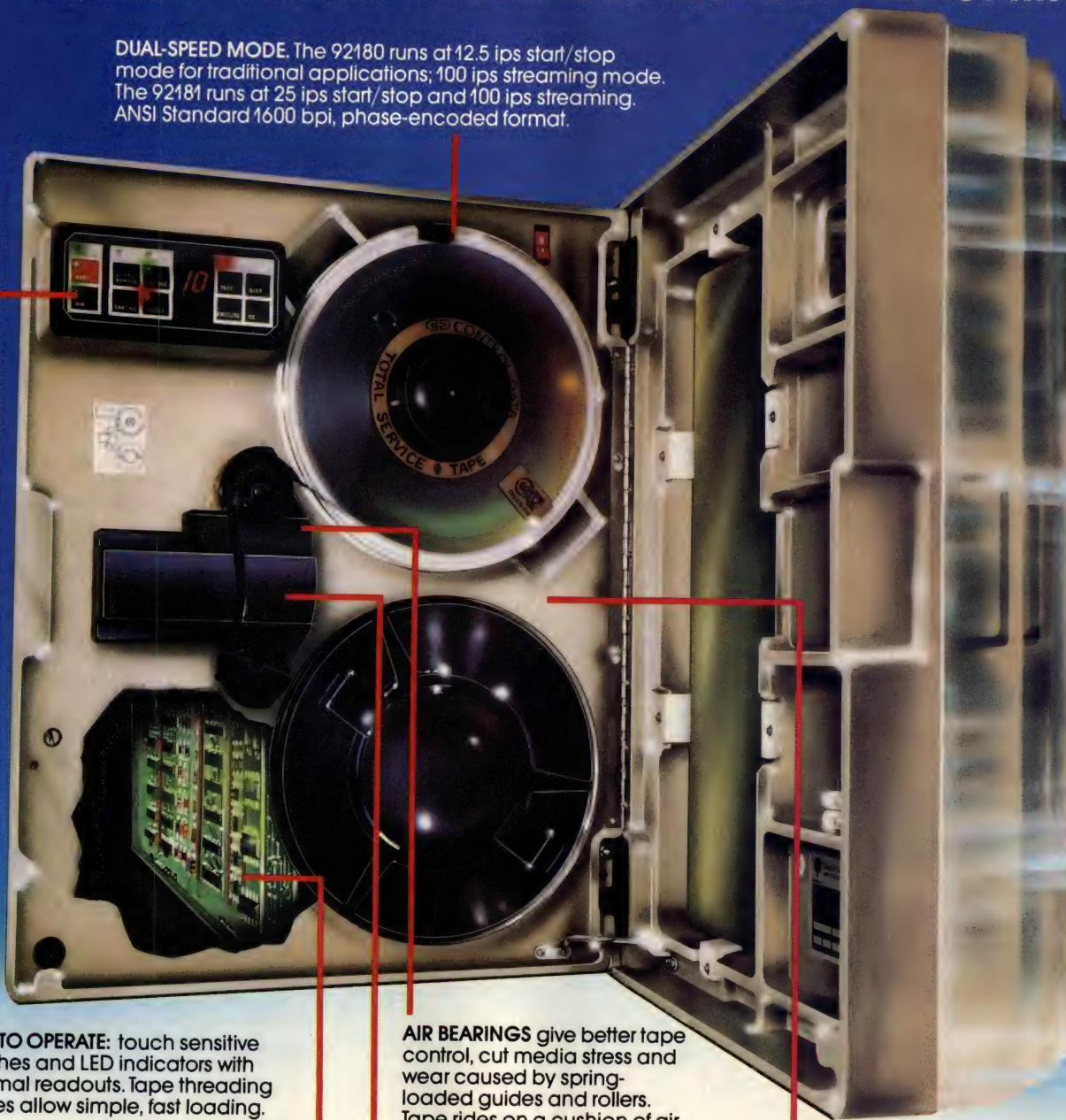


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CIRCLE NO 30

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CIRCLE NO 31

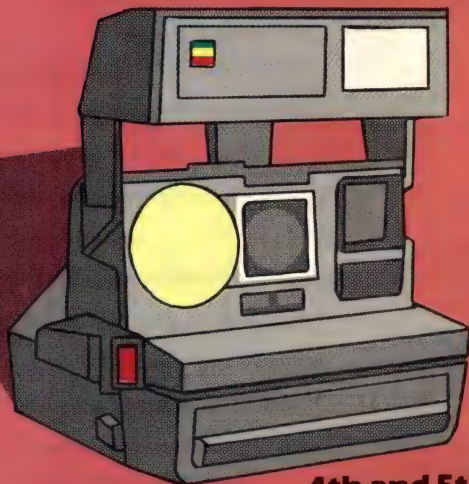
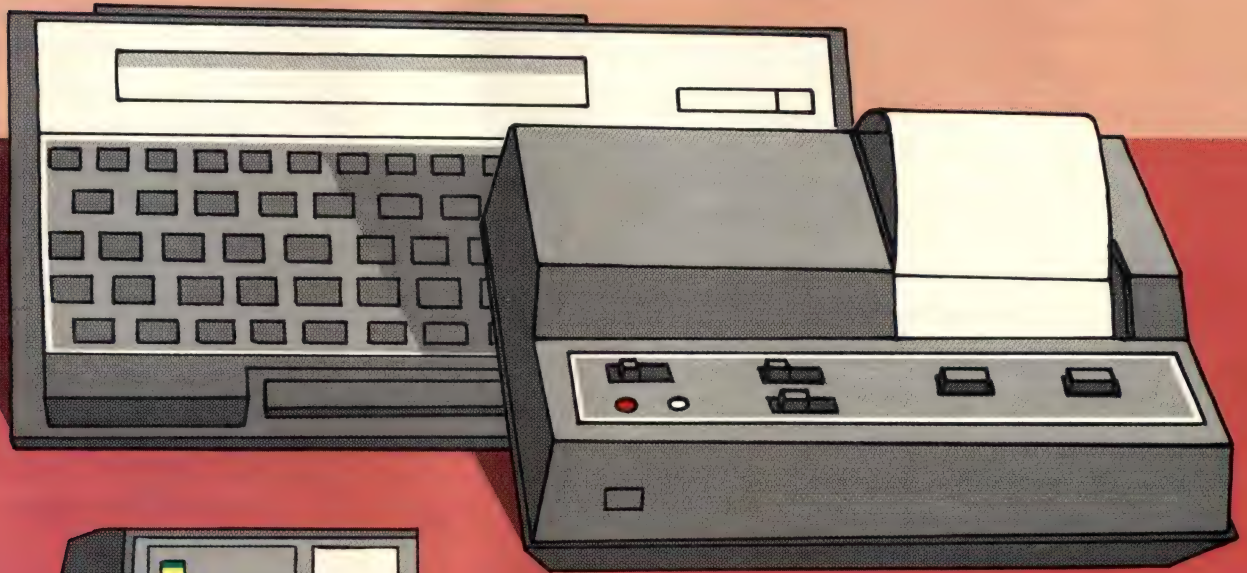


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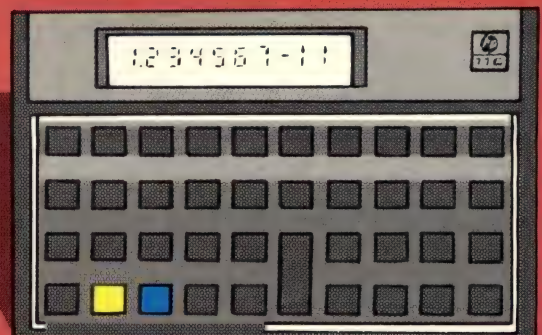
1st Prize

Hewlett-Packard HP-75C Personal Computer with Printer/Plotter



4th and 5th Prizes

Polaroid 660 Sun Camera



6th and 7th Prizes

Hewlett-Packard HP-11C Calculator

Enter the EDN Reader's Vote advertising contest. It's as easy as 1...2...3.

1. Select the 10 ads in the Jan. 6 issue of EDN that you think your fellow readers will choose as being the most helpful, informative, and attractive.
2. List your selections on the entry card provided.
3. Mail by February 12, 1983.

ATTENTION ADVERTISERS: A separate contest for advertisers makes prizes. Similar contest rules apply.

And remember...the ten winning ads receive a free re-run.

CONTEST RULES

1. List your Top 10 selections on the entry card provided. Be sure to indicate the name of the advertiser (company or organization) and the Information Retrieval Service Number for each advertisement selected. Do NOT use page number. (Ads placed by Cahners Publishing Company, EDN or other Cahners' publications cannot be considered in this contest.)

2. No more than one entry may be submitted by any one individual. Entry blank must be filled in completely, or it will not be considered.

3. To qualify, you must be engaged in electronic design engineering, supervising or managing design engineering or setting standards for design components and materials.

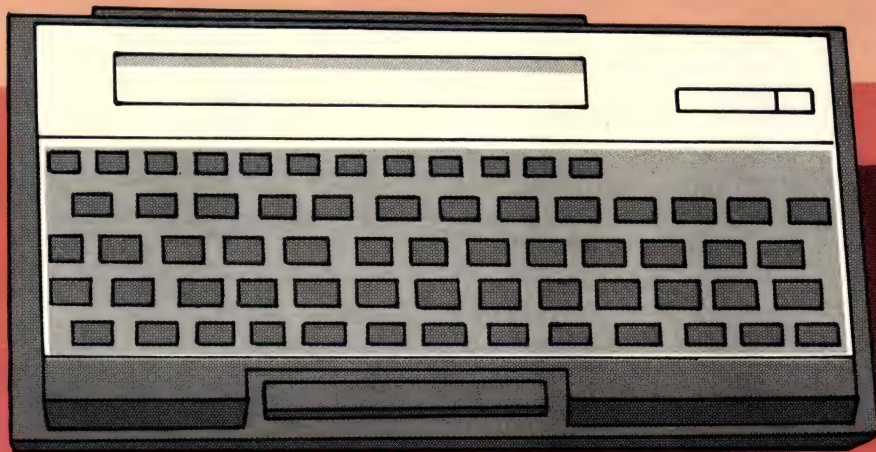
4. Contest void where prohibited or taxed by law. Liability for any taxes on prizes is the sole responsibility of the winners.

5. Entries that most closely match the rank will be declared winners.

6. Entry cards must be postmarked before February 12, 1983.

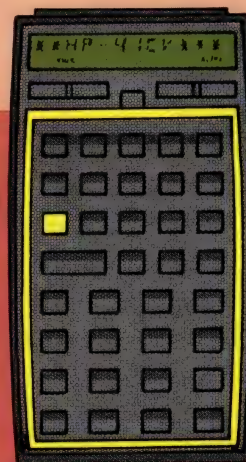
7. In case of a tie, the earliest postmark will determine the winner. Decisions of the contest judges will be final.

8. In the event that a prize is not available, publisher may substitute an alternate prize of equal value without prior notice. No cash payments or other substitutes will be made.



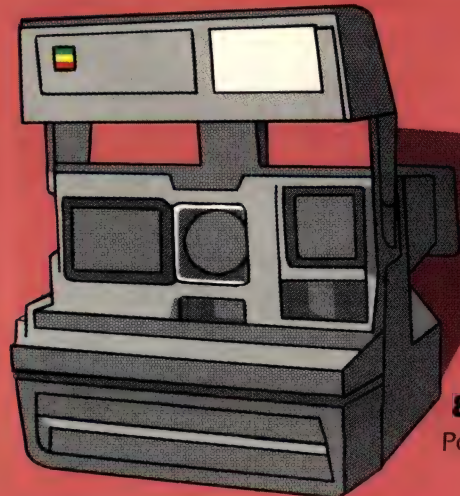
2nd Prize

Hewlett-Packard HP-75C Personal Computer



3rd Prize

Hewlett-Packard HP-41C Calculator

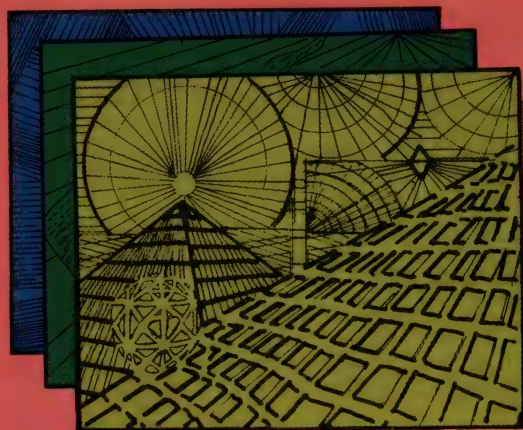


8th Prize

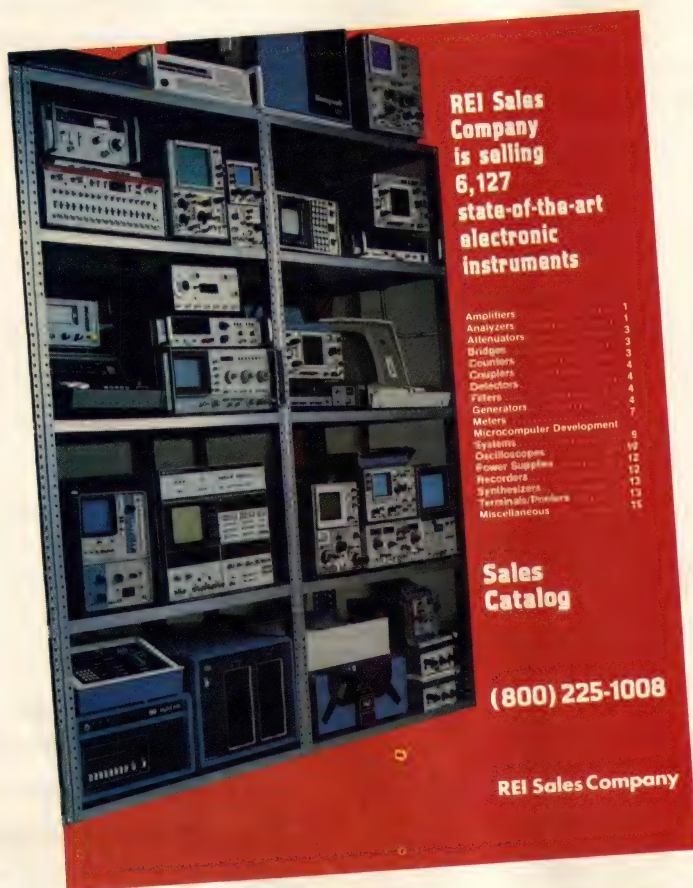
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CIRCLE NO 32

Signals & Noise

incompatibility problem, most CAD-system vendors are investigating ways to instill their products with software that converts internal data formats to a standardized protocol. Many CAD systems, for example, now include routines that provide data compatible with the Caltech Intermediate Format (CIF), a communication protocol rapidly emerging as the standard for CAD-database transfers.

(Finally, rapidly decreasing CAD-system prices will soon allow even small companies to own their own layout and design equipment. Then, designers will be able to exercise total control over database creation and revision. In the meantime, though, we can only encourage designers to consider the benefits that CAD offers—and the competitive and economic pressures that demand fast, well-documented design cycles—before yielding to frustration.)

Our mistake

A product writeup in the October 13 issue of EDN provided the wrong model number for UCE Inc's new LCD. The unit is the 3280 and sells for \$19 (5000).

Try a different configuration

Dear Editor:

As much as I appreciated Jim Williams's article on current-source circuits (EDN, September 1, pg 169), I feel that some errors and omissions need rectifying. Jim failed to alert users of the circuits detailed in Figs 3 and 4 to the errors arising from changes in transis-

Continued on pg 40

Free samples speak louder than words.



Motorola is delivering High Speed CMOS Logic now, and we'll send you a packet of 10 free circuits to prove it.

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Brief Verbal Application Description*

My signature signifies Release from designer. _____

Signature

*Application will not be returned and becomes the property of Motorola. Schematic or block diagram must be enclosed.

139 EDN 1/6/83

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INTERSil

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Gentlemen,
I'm high on low power. Send me everything I need to know about the IM6716 CMOS EPROM with on-board latches.

Name _____
Phone _____
Company _____
Address _____
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State _____ Zip _____
Application _____
Annual parts requirement _____



☐ Please send me a free Mark Twain poster from your Famous Quotes Series.

tor h_{FE} with temperature; it's much better to use an FET for Q_1 in Fig 3 and Q_2 and Q_3 in Fig 4. In addition, the circuit in Fig 5 exhibits a large time-constant increase in charging current when Q_3 is turned off, because of thermal effects in Q_2 .

My main criticism, however, pertains to Fig 9. Apart from the obvious pinout errors and misconnections to the LM3524, VMOS transistors and LM363, what astounds me is the use of a precision high-CMRR instrumentation amplifier (such as the LM363) with such an appalling input circuit. At least Jim might have consulted National Semiconductor's *Linear Applications Handbook AN29-14* and reminded readers of the need to match the 60-k Ω and 1-M Ω resistors. This circuit's output resistance could be as low as 2700 Ω —hardly a 200V-compliance current source!

An improved current-monitoring configuration would include the 100 Ω sampling resistor in the negative output from the bridge rectifier and smoothing capacitor. It would eliminate any common-mode effects arising from load-resistance changes. Provided the input signal could be changed to 0 to -5V, the feedback from the 100 Ω resistor could be directly connected to the LF411.

Yours truly,

Peter M Clare

*Principal Electronic Engineer
Bell & Howell Ltd
Basingstoke, Hampshire, UK*

Author's reply

It's true that h_{FE} vs temperature will affect operation, but in many (most) applications, the relatively small I_C/I_B effect is not objectionable—to attain the most precise operation, an FET

or FET/transistor combination is a better refinement of the basic circuits.

Quite frankly, Mr Clare's current-sensing scheme, which uses the fully floating transformer secondary, is a vastly superior method—even if the 163's input resistors are ratio matched (which I neglected to mention). I'm a little embarrassed that I didn't see it myself, and I unhesitatingly recommend it over my original approach. LM163s are cheap—but not *that* cheap.

Sincerely,

Jim Williams

Palo Alto, CA

Rise to the challenge

Dear Editor:

In your article on minimizing stress (EDN, October 13, pg 161), you state that "If, for example, Marketing insists on last-minute modifications...your objections will probably go unheeded." You also suggest that "factors beyond your con-

Continued on pg 44

NEXT TIME

EDN's January 20 issue will feature a Special Report on engineering-function add-ons and add-ins for personal computers, plus informative and useful design features and Technology Update pieces on a variety of topics:

- Our sixth annual μ C Support Chip Directory
- Varied applications for the Howland current source
- Developments in CP/M electronics-engineering software packages

...and much more. Also look for our regular Design Ideas and μ C Design Techniques departments, plus a Technology Update on integrated optics. You can't afford to miss this issue!

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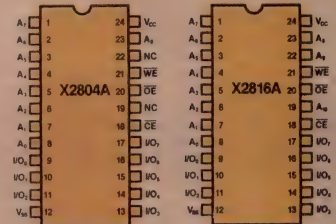
functions, including programming, using 5 volts only. So you can alter data in-system by keyboard. Or by downloading with your main-frame computer.

Xicor E²PROMs even have an optional programming mode that's compatible with existing high-voltage E²PROMs, so you can use them in the products you've already designed. And Xicor E²PROMs are priced competitively as well.

Why wait? Cut component, assembly, and design costs now . . . save board space . . . increase product reliability, too. It's easy with the 5V-only E²PROMs from Xicor. Call or write today for more information. It will be music to your ears.

PART NO.	5V ONLY	ELIMINATES EXTERNAL HARDWARE	INPUT ADDRESS AND DATA LATCHES	INTERNAL TIMING OF WRITE CYCLE	AUTOMATIC ERASE	RAM COMPATIBLE	MAXIMUM WRITE TIME
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XICOR X2816A	YES	YES	YES	YES	YES	YES	10 ms
2817	NO	NO	YES	YES	YES	NO	75 ms
5213	YES	NO	NO	NO	NO	NO	20 ms
2816	NO	NO	NO	NO	NO	NO	20 ms

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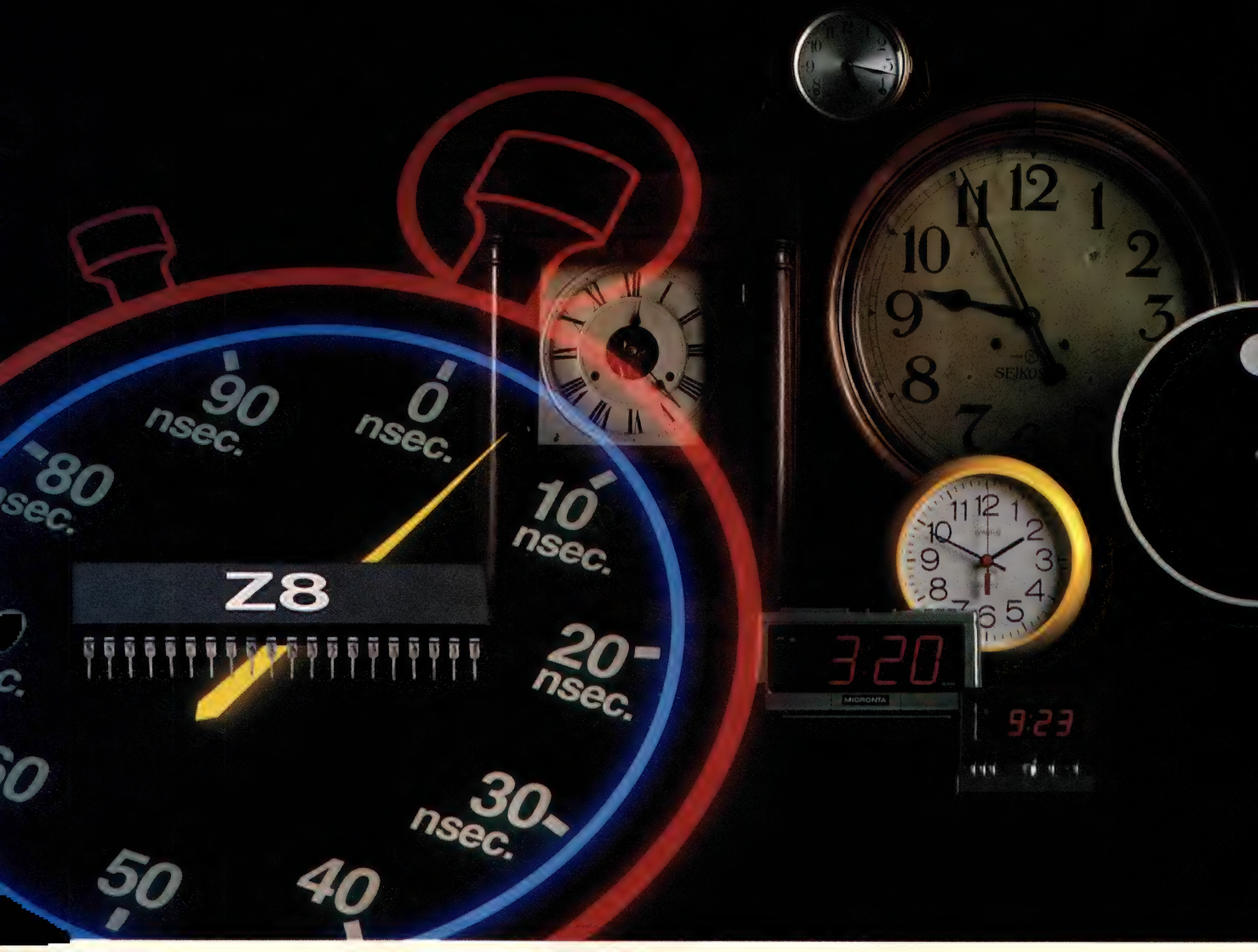
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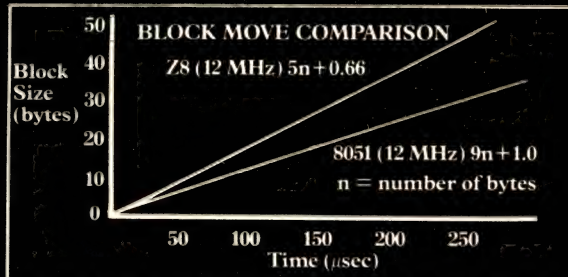
CIRCLE NO 34



Zilog's new 12 MHz one-chip computers



give a new meaning to your time.



You can move any block of data faster than you ever thought possible with Zilog's new 12 MHz, 8-bit, single-chip microcomputer because it's the only single-chip solution that incorporates advanced general-purpose, register-oriented architecture. This easy-to-understand architecture permits over 30% higher code densities than primitive accumulator designs and allows appreciably reduced product development time. But that's not all.

There's a new 4K ROM too! Add that to the Z8[®] family's 12 MHz option and the way is clear for you to add significant performance and/or features to your present system without a major redesign effort. In fact, the new Z8's can challenge the performance of many 8-bit machines while dramatically reducing your parts count and power consumption. And, you'll appreciate our aggressive, competitive pricing for the whole Z8 family.

Consider these key Z8 design benefits.

- Up to 4K bytes of ROM and 144 bytes of internal RAM
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 - Two programmable 8-bit counter/timers
- And all Z8 chips are available in 8 and 12 MHz models.

To come up to speed on all 8 of the fast moving Z8 family, simply fill out the coupon and mail it to Zilog, Inc., Components Tech. Publishing, 1315 Dell Avenue, Campbell, CA 95008. Or call TOLL FREE: (800) 272-6560.

- ☐ I'd like more information at this time.
☐ Please have a salesman contact me.

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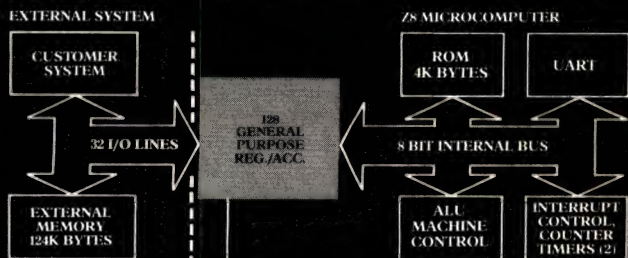
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Z8 EDN 1/6/83



All 128 registers can be used as accumulators or general-purpose registers (index registers, address pointers, etc.). 4 registers are dedicated as I/O ports.

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CIRCLE NO 35

Signals & Noise

trol could prevent you from fighting successfully."

If Marketing does insist on changes, someone must agree to provide the manpower and time to make them. That's a challenge; God forbid, should we never get hit by challenges? If we don't have the chance to respond to challenges, how can we show our merit?

As my old boss said when I was working on a tobacco farm, "We're gonna finish off this damn field by 5 o'clock if takes us all night!"

Best regards,

Bob Pease

Engineer

San Francisco, CA

Circuit design ignores potential problems

Dear Editor:

I like the circuit in the Design Idea, "Generate HV with auto ignition coil" (EDN, September 15, pg 193), but it has a flaw.

Many power lines have drop-

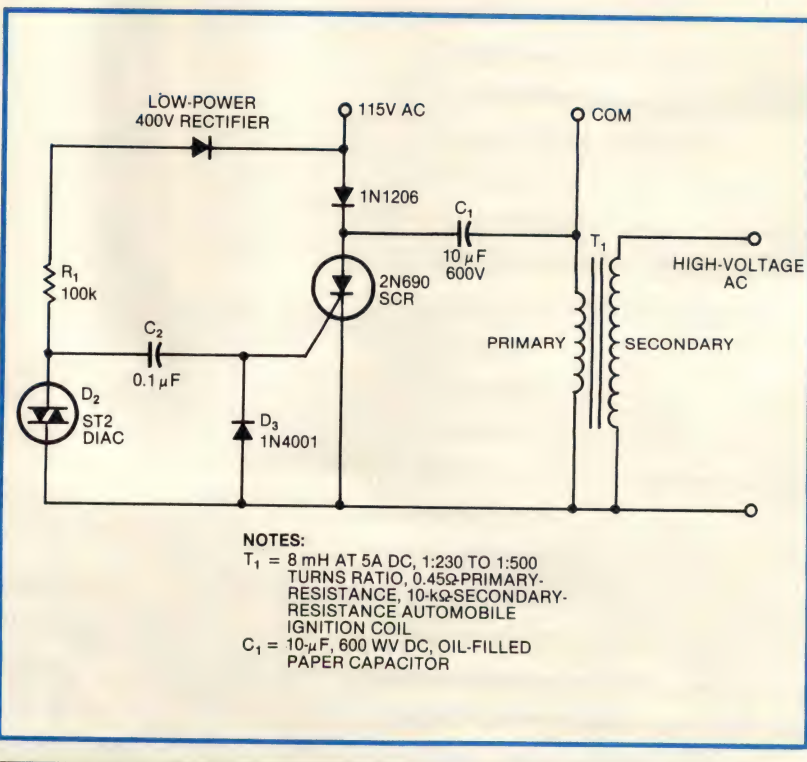
outs that last a half cycle or so. In this circuit, a dropout of about 135°, or $\frac{3}{8}$ of a cycle, can cause triggering of the SCR into the positive half cycle of the input sine wave. Any dropout longer than that causes spurious firing in the first quadrant of the input sine wave if the line comes back up in the fourth quadrant (in the -45 to -22° region). Such firing occurs because the phase shift introduced by R_1 and C_2 moves the firing point for such an input into the first quadrant.

Potential results are blown fuses, popped circuit breakers, smoke and fire, because nothing limits the current in this mode. I suggest that the circuit be modified as shown in the nearby figure to use the primary of the transformer to limit the current for these occasional mistriggers.

Very truly yours,

Arnold Frisch

Chief Electronic Engineer
Electronic Systems Laboratory
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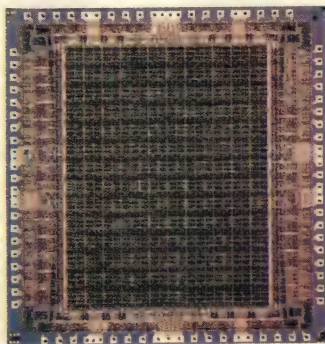
Upward compatibility of US-based CAD system from 250 gates to 10,000 gates.

High speed and low power capabilities and at low cost.

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Ten week turn around time after logic simulation.

Our current offerings are listed below and more are on the way. Look for 3,000 Gate ECL, 5000 Gate TTL and 10,000 Gate CMOS Arrays from NEC this year. Up to now it may have been hard to pick a gate array supplier. Not anymore. NEC's here.



TTL GATE ARRAY

Part Number	μ PB6101X	μ PB6102X	μ PB6110X	μ PB6120X	μ PB6130X
Integration (Gate)	250	550	1000	2000	3000
Delay Time/Gate	2.5ns	2.5ns	2.0ns	2.0ns	2.0ns
Number of Output Buffers	32	52	50 (132pin) 34 (72pin)	64	80
Number of Input Buffers	38	64	118 (132pin) 60 (72pin)	142	184
Power Dissipation/Gate	1.4mW	1.4mW	1.6mW	0.74mW	0.74mW
Input Output Interface	ALS	ALS	LS	ALS	ALS
Technology	ALS	ALS	PSA	PSA	PSA

ECL GATE ARRAY

Part Number	μ PB6301X	μ PB6310X	μ PB6320X
Integration (Gate)	300	1200	2000
Delay Time/Gate	0.5ns	0.7ns	0.7ns
Number of Output Buffers	28	48	48
Number of Input Buffers	56	88	108
Power Dissipation/Gate	5.4mW	1.9mW	1.9mW
Input Output Interface	100K Compatible		
Technology	Advanced Bipolar Process		

CMOS GATE ARRAY

Part Number	μ PD65003X	μ PD65002X	μ PD65010X	μ PD65020X	μ PD65040X	μ PD65060X		
Integration (Gate)	400	800	1300	2100	4000	6000		
Delay Time/Gate	3ns	3ns	3ns	3ns	2ns	2ns		
Number of Output Buffers	36	50	64	80	120	136		
Number of Input Buffers	38	50	64	80	120	136		
Power Dissipation/Gate	30 μ W/Gate 1.5mW/Output				20 μ W/Gate 1.5mW/Output			
Input Output Interface	TTL, CMOS Compatible							
Technology	Silicon Gate CMOS, 2 Layer Al Metallization							

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CIRCLE NO 36

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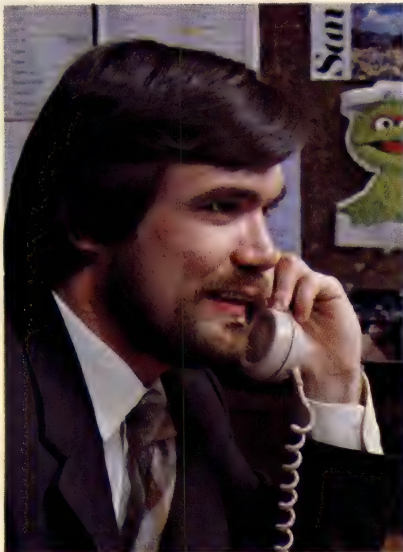
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CIRCLE NO 37



EDN strives to know and serve you even better

When talking in technical jargon, engineers often describe a person who seems uncontrolled or insensitive to his surroundings and the people near him as "running open loop." Trade journals run the same risk; thus, it's necessary for them occasionally to study exactly *who* their readers are and what kind of information they need.

Last fall, EDN did precisely that: We conducted an extensive survey of you—our readers. We'd like to thank all who took the time to respond and give us some valuable feedback. And we think you'll be interested in a summary of the results, presented in the story beginning on pg 79.

One of the significant findings of our study showed that a large majority of respondents—90%—consider the trade press one of their most important sources of new-product and application information. But how do these time-pressed designers cope with the large amounts of information that cross their desks each week? Haven't you ever suddenly needed information you'd recently seen in a trade journal—but been unable to remember exactly when or where it appeared?

If you've ever faced this dilemma, you'll be delighted with EDN's first annual Technical Article Database (pg 191). This extensive index lists articles that appeared in the last year—not only in EDN, but also in the other major electronics trade journals.

We believe that this database will prove a great time saver in your work and that it further emphasizes EDN's commitment to publishing a magazine that above all takes your needs into account. In this way, we hope to even better meet your needs. And we hope that you in turn will continue to vote us the best-read electronics trade journal, just as you have in 87% of all independently conducted readership studies in the past five years. We thank you for your loyal support and pledge to continue searching for ways to better serve you.

Paul G Schreiber
Editor

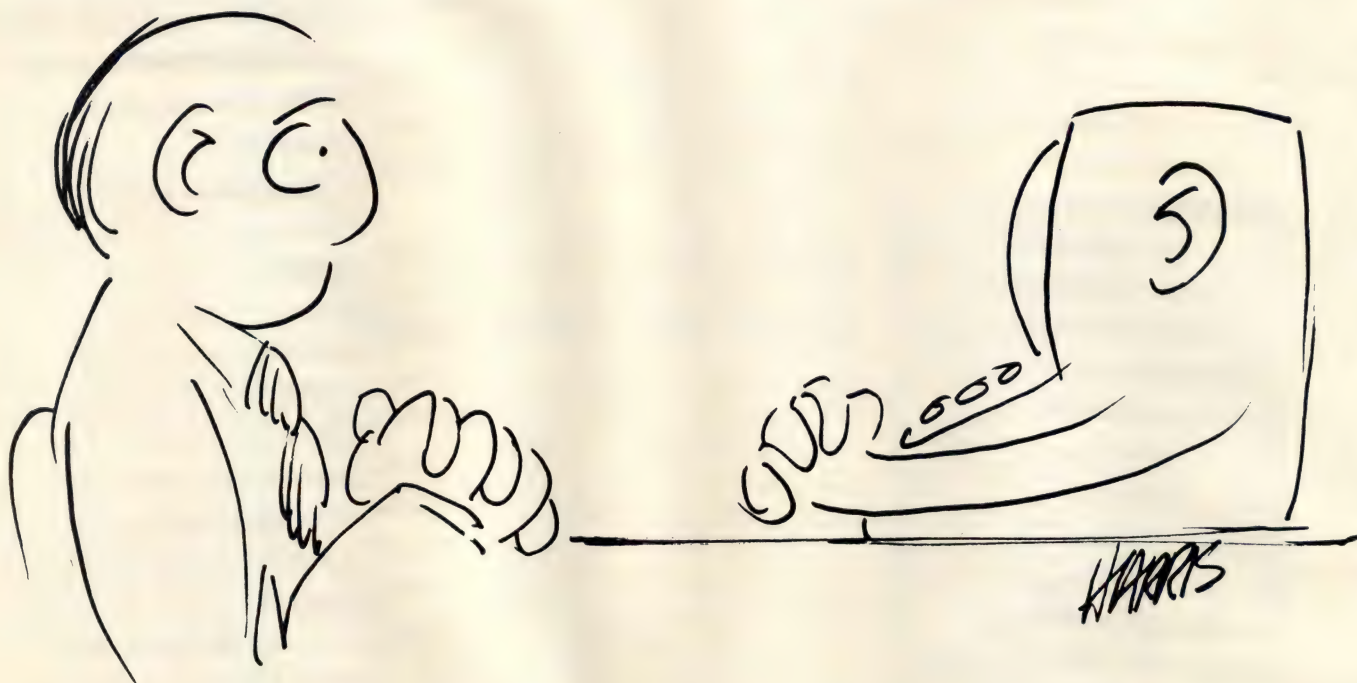
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Comprehensive short courses and workshops on voice recognition

Explore the capabilities voice recognition offers, find out how you can benefit from this technology, and learn how to put it to work for you in this comprehensive introduction to all aspects of voice recognition.

In two days, you can acquire background knowledge and practical advice about this fascinating field. The third day is an advanced workshop featuring practical "how-to" for those presently involved in voice recognition.

Seminar leader Dr. Wayne A. Lea, a distinguished expert in voice recognition, has published several books and countless articles on that topic. In addition, he teaches speech recognition at USC. Dr. Lea has several degrees in science, linguistics and engineering.

Seminar dates: February 16-18, 1983 / New Orleans, LA April 11-13, 1983 / Boston, MA

Registration fee: Seminar: \$475 Workshop: \$295 Registration fee for the seminar and workshop includes instruction, live demonstrations, literature, breakfast and lunch.

Register now - attendance is limited.

Send attached coupon to Dr. Wayne A. Lea, Speech Science Publications, 889 Sanford Court, Santa Barbara, CA 93111 or call 805/683-1323.

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☐ February Seminar ☐ February Workshop ☐ April Seminar ☐ April Workshop
Payment is enclosed.
☐ **I'd like to know more. Send me information.**

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How Texas Instruments and Mitel team up for the last word in communications.

An advanced work station now ties together virtually all forms of modern communications with word and data processing. In one compact package.

Developed by the Mitel Corporation, with a strong assist from Texas Instru-

ments, the desk-top station offers outstanding communications capabilities to the general office.

TI helped make the station possible by supplying early samples of its new TMS4416 64K DRAM, organized 16K x 4. The

ByFour™ organization provided highly efficient memory utilization and essential space savings.

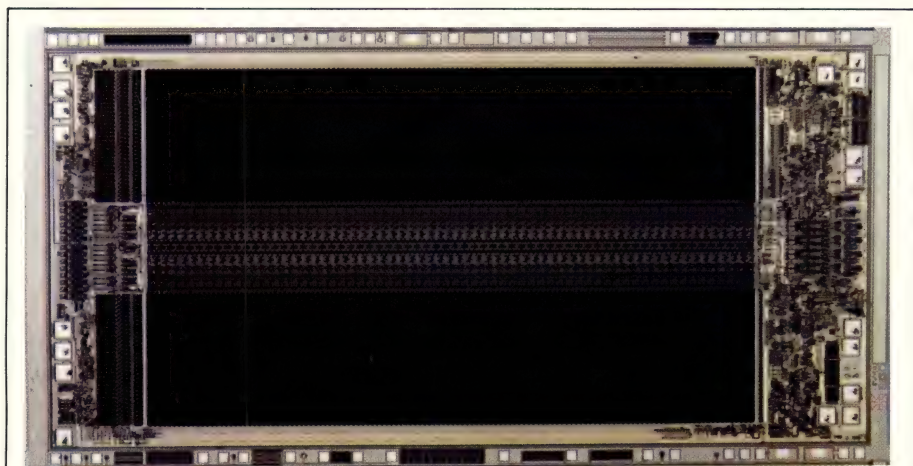
Turn the page to see how 16K x 4 memory organization can result in more efficiency and space savings for you. ►

The multi-functional SUPERSET 7 allows people to simultaneously access and share voice, text, and image information through a friendly, compact work station.

The TMS4416 proved to be the key to solving Mitel's memory problem. Only 16 TMS4416s provided the needed video display memory — a four-to-one parts reduction over 16K DRAMs. And a 50%

◀ **A single board** containing TI's new TMS4416 16K x 4 DRAMs allowed Mitel to meet size constraints yet provide required memory density in the design of an advanced, compact communications workstation (prototype board shown).

16K x 4 DRAM organization cuts space by 50% in Mitel system.



TI's new TMS4416 16K x 4 DRAM uses advanced design concepts developed for TI's pacesetter TMS4164 64K DRAM. For example, square array architecture results in less power dissipation, lower junction temperatures, greater reliability, and lower cost.

space savings that allowed Mitel to incorporate more functionality into the SUPERSET 7.

ByFour organization utilizes memory efficiently

The 16K x 4 organization provided excellent utilization of the memory.

The TMS4416 interfaces efficiently with the 16-bit processor used in the SUPERSET 7 work station. It allows the processor to access four bits of information at one time — as opposed to one bit at a time in 64K x 1 DRAMs.

Using the TMS4416 gave Mitel other benefits: Improved resolution. Significant cost reductions. Power savings — only one 5-V supply required. Improved reliability — fewer parts and interconnects.

Other TI products enhance system versatility

Mitel uses many other TI semiconductors in its ICS system. Main memory of the SX-2000 consists entirely of TMS4164 64K DRAMs.

In addition, Mitel employs TI's TMS5220A speech synthesis modules in its telephone operation. The speech analysis took place at the TI Regional Technology Center (RTC) in Chicago. At the RTC, Mitel personnel worked with TI engineers to verbalize all the

variables that confront the user of a telephone.

ByFour organization right for many applications

Although new, the TMS4416 is already proving itself in the Mitel equipment. And, because of its high bandwidth, it is finding more uses. Rapidly.

In personal and small business computers. Intelligent terminals requiring 16K- and 32K-byte modularity. Single-board microcomputers. Microprocessor-based industrial equipment. And more.

For details on the TMS4416 (16K x 4) and the TMS4164 (64K x 1), now available in the industry's first high-density, plastic chip carrier, check numbers 1 and 2 on the coupon.

TMS4416 16K x 4 64K DRAM

	ACCESS TIME ROW ADDRESS (MAX)	ACCESS TIME COLUMN ADDRESS (MAX)	READ OR WRITE CYCLE (MIN)	READ, MODIFY, WRITE CYCLE (MIN)
TMS4416-15	150 ns	80 ns	260 ns	360 ns
TMS4416-20	200 ns	120 ns	330 ns	440 ns
TMS4416-25	250 ns	150 ns	410 ns	560 ns

TMS4164 64K x 1 64K DRAM

	ACCESS TIME ROW ADDRESS (MAX)	ACCESS TIME COLUMN ADDRESS (MAX)	READ OR WRITE CYCLE (MIN)	READ, MODIFY, WRITE CYCLE (MIN)
TMS4164-15	150 ns	100 ns	260 ns	285 ns
TMS4164-20	200 ns	135 ns	330 ns	345 ns
TMS4164-25	250 ns	165 ns	410 ns	455 ns

New TI DRAM controller slashes design time

TI's new TMS4500A DRAM controller allows you to get the speed, density, and power-saving features of DRAMs in any size system. Big or small.

Cuts part count

The TMS4500A system controller provides address multiplexing, timing, and control and refresh/access arbitration functions all on one chip.

Result: It makes designing much easier and faster. Because everything you need to interface between DRAM memory and the processor is in a single chip. The TMS4500A eliminates from four to 16 parts, compared with conventional controllers. Think of the board space savings and power reductions possible when you combine two TI TMS4416 DRAMs with a TMS4500A to form a 16K-byte, three-chip memory.

The first synchronous DRAM controller, the TMS4500A has no crystals. No delay lines. No RC networks. Operates directly from microprocessor clock.

In addition, refresh/access arbitration is on chip. It's handled synchronously with the system clock. Consequently, the TMS4500A eliminates arbitration delays and metastability problems associated with asynchronous operation.

Controls all popular-size DRAMs

The TMS4500A controls the operation of 4K, 16K, and 64K DRAMs from any manufacturer. It provides address multiplexing, cycle timing, and refreshing for all multiplexed-address DRAMs. So, it makes dynamic RAMs appear static to the system.

It also interfaces easily with popular microprocessors.

TI's new DRAM controller comes in a 40-pin, 600-mil, plastic dual-in-line package. A single TMS4500A drives up to 44 DRAMs. When multiple controllers are used, they can be synchronized or interleaved with the processor.

For more information on the TMS4500A, check number 3 on the coupon on the next page.

Only TI distributors offer two 64K DRAMs off the shelf.



Now, you can get the industry's most advanced 64K DRAMs. In quantity. They're as near as your TI distributor. Choose the industry-leading TMS4164 with 64K x 1 organization. Or the new TMS4416, organized 16K x 4.

Your TI distributor also has a military version of the 64K x 1 TMS4164. The SMJ4164 DRAM is processed to MIL-STD-883B. It's available in either STD C-DIP or ceramic chip-carrier packages.

Both TMS4164 and TMS4416 DRAMs offer 150-ns access time, and power dissipation as low as 140 mW typical—the industry's best combination of speed and power. In addition, innovative square array architecture cuts the number of sense amplifiers in half, greatly enhancing system reliability.

No one else offers you two 64K DRAM versions. So, when you need 64Ks, call your TI distributor first.

Texas Instruments P. O. Box 202129
Dallas, Texas 75220

Please send me more information on:

- ☐ 1. TMS4416 16K x 4 64K DRAM
- ☐ 2. TMS4164 64K x 1 64K DRAM
- ☐ 3. TMS4500A DRAM Controller
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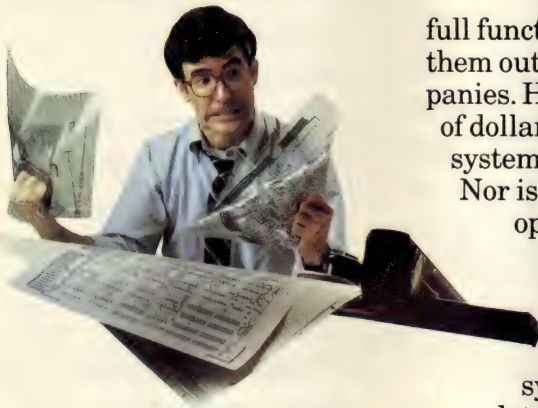
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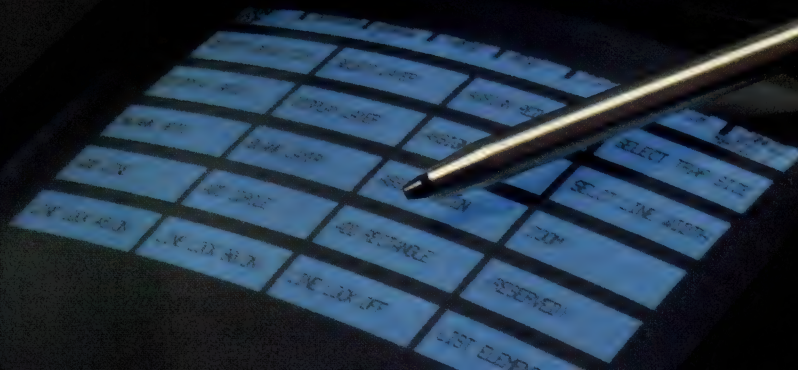
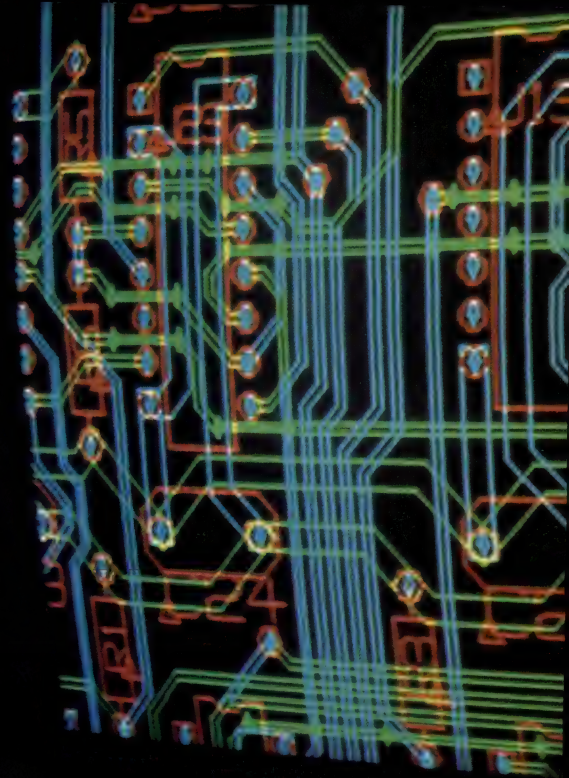
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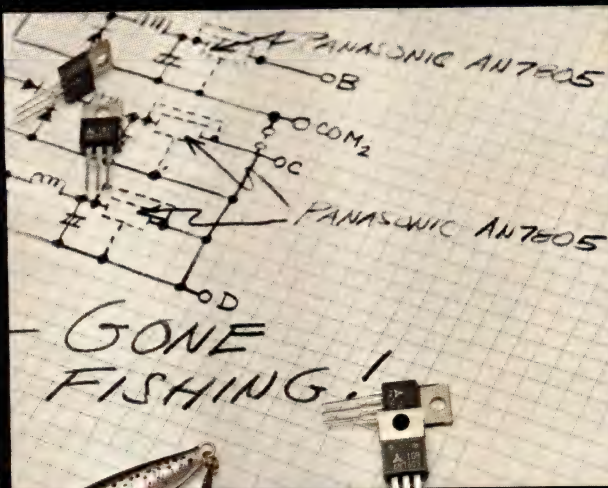


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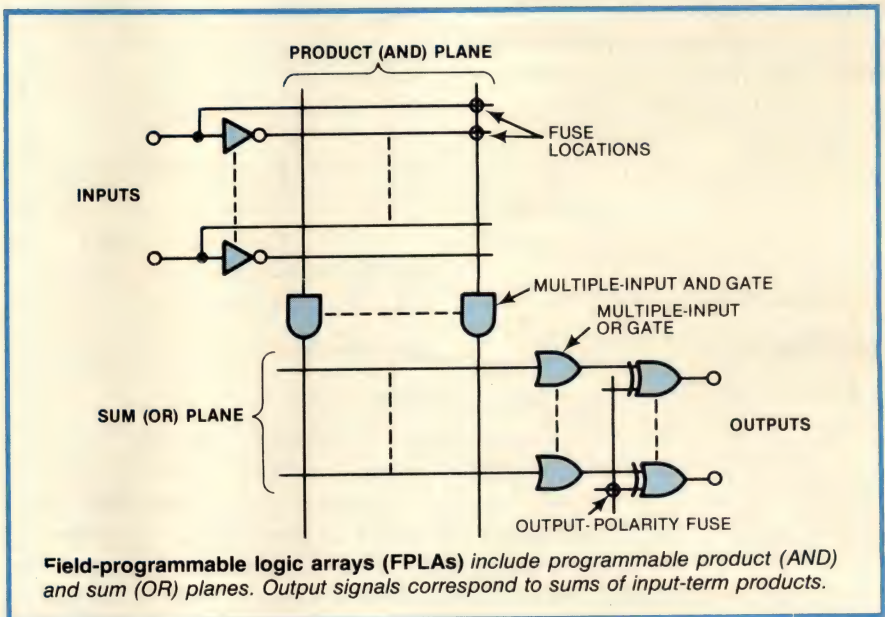
Field-programmable logic arrays bridge the standard-IC/gate-array gap

Andy Rappaport, Associate Editor

Once considered endangered species in light of rapidly developing gate-array and custom-VLSI technologies, field-programmable logic arrays are receiving increased attention from designers striving to make their digital circuits more compact without incurring large engineering costs. The devices' unique internal architectures, coupled with their ability to promote fast, interactive product design cycles, allow high-speed, medium-density systems to benefit from low production costs, optimized logic implementations and simple revisability. Moreover, field-programmable logic families consist of standard, second-sourced components and thus allow designers to create customized circuit elements without risking long delivery times and without making production commitments to unproven designs.

Because programmable logic devices offer advantages over both standard components and semicustom ICs, they are likely to enjoy symbiotic relationships with the same components that once threatened their existence: Gate arrays and VLSI components provide efficient means of implementing large, fixed-design circuit blocks, while programmable arrays furnish design reconfigurability and allow circuit prototyping.

In many ways, therefore, field-programmable devices will become to VLSI chips what PROMs are to μ Ps: a way to customize highly complex components and systems for specific applications. In addition, array logic's ability to efficiently



translate state equations to functioning silicon provides a vehicle for constructing circuits that don't lend themselves to implementation on chips containing randomly distributed, independent gates. As a result, in their generalized forms, array-logic architectures are finding use in and around all types of VLSI circuits.

Feature sets evolve

Field-alterable-device architectures and features are changing to better suit such applications involving combinations of semicustom, standard VLSI and programmable logic. Manufacturers are refining their field-programmable-IC families to reflect the characteristics of emerging digital systems and to provide the speed, power, flexibility and cost compromises that allow users to best exploit the devices' unique advantages. Furthermore, to enable field-programmable ICs to

more effectively and economically replace standard SSI and MSI components, device vendors are continuing to evolve programmable-logic design tools and testing methods. And for applications that require large production volumes of user-configured parts, some vendors hope that mask-defined versions of programmable devices will emerge as viable alternatives to gate-array and standard-component designs.

Programmable-logic components are evolving differently from VLSI circuits, however. Unlike those of conventional logic forms, programmable-array densities don't depend primarily on photolithographic limitations. Instead, they are controlled by pin-count, power-dissipation, testability and programmability constraints.

Although currently available programmable arrays employ no more than 4000 fuses—far fewer than the

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64,000 incorporated in some bipolar PROMs—most vendors believe that before programmable-device densities can reach levels comparable to those of other logic and memory forms, users must learn to structure their designs in ways that make optimal use of array-type logic (see **box**, "Employ a top-down methodology"). In addition, vendors must provide architectures that offer sufficient functionality to justify the costs and power requirements of large programmable arrays.

According to Signetics applications manager Bill Smith, for example, before users accept 40-pin and larger programmable arrays, they must realize that the devices represent more than simple collec-

tions of gates. Properly used, large programmable devices can restructure designs in the same way that μ Ps do; thus, they perform more powerful functions than simple logic replacement.

Adds Harris Corp programmable-logic marketing manager Bob Helsby, logic designers typically mistrust devices they must program. Therefore, users must learn to accept programmable arrays conceptually before they can apply large devices optimally.

Distributed-input architectures

Programmable devices present conceptual problems because their internal structures don't resemble the discrete gates with which

designers are most familiar. Originally developed as offshoots of PROM technology, they employ planar distributed gates that allow multiple-input AND and OR functions.

The oldest field-programmable logic arrays (FPLAs), developed by Signetics and employing the firm's integrated-fuse-logic (IFL) process, embody architectures identical to those of bipolar PROMs but with uncommitted address decoders. Thus, the devices include AND (product-term) arrays that feed OR (sum-term) planes; output functions exist as arbitrarily assigned sums of input-term products. You can view a basic FPLA as a PROM in which data bytes correspond to user-

Employ a top-down methodology

To properly exploit any programmable-logic device, you must include it as an integral element in your design process. Because array-logic architectures differ significantly from standard SSI and MSI devices, direct TTL-replacement applications don't always realize the full benefits of distributed-input circuits.

Programmable arrays typically replace four to six 7400 Series packages when used as gate-for-gate substitutes, but they can eliminate 10 times as many components in applications designed specifically for programmable-logic implementations. In addition, when used to replace multistage logic circuits, programmable devices can eliminate race conditions: All signal delays within array logic remain equal (provided all signals include equal amounts of feedback), so programmable devices properly employed in critical circuit paths often stabilize designs.

Realizing such array-logic advantages requires that you approach design tasks with a top-down methodology. According to Signetics applications manager Bill Smith, instead of trying to drop programmable components into gate-level circuits, designers must determine which circuit sections can profit most from programmable-logic implementations. They then must directly design fuse-programming patterns for specific circuit functions rather than for gate replacements.

In applications involving gate arrays and standard VLSI components, for example, Smith suggests partitioning designs with programmable logic in mind. Major function blocks typically work best in VLSI form, but you can use programmable components as

flexible peripherals, performing interface functions between major circuit elements and absorbing customer changes and design revisions. In addition, programmable devices can effectively reduce VLSI-circuit pin counts; a 16-input/8-output FPLA or PAL can halve the number of I/O pins that a gate array requires and thereby save sufficient packaging costs to justify its own expense. Furthermore, properly partitioned multiple-package designs exhibit increased overall reliability.

To create a tool for top-down system design and partitioning, Smith is developing a logic-development program that accepts input data in flowchart form. The software will use diagrams based on state transitions to define system activity and will allow designers to easily determine the best implementation form—random logic, FPLA, μ P or gate array—for each circuit section. Moreover, such a structured design approach simplifies the algorithms for automated logic partitioning and design.

Top-down design also results in more efficient logic implementations. Array-logic programmers and design software accept input data in Boolean-expression or truth-table form, permitting direct translations from behavioral descriptions and state equations to circuit elements. According to AMD bipolar applications engineer Warren Miller, designers who start using programmable logic as TTL replacements ultimately find themselves assigning large circuit blocks to array devices long before expanding schematics to the gate level.

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defined rather than sequential input addresses.

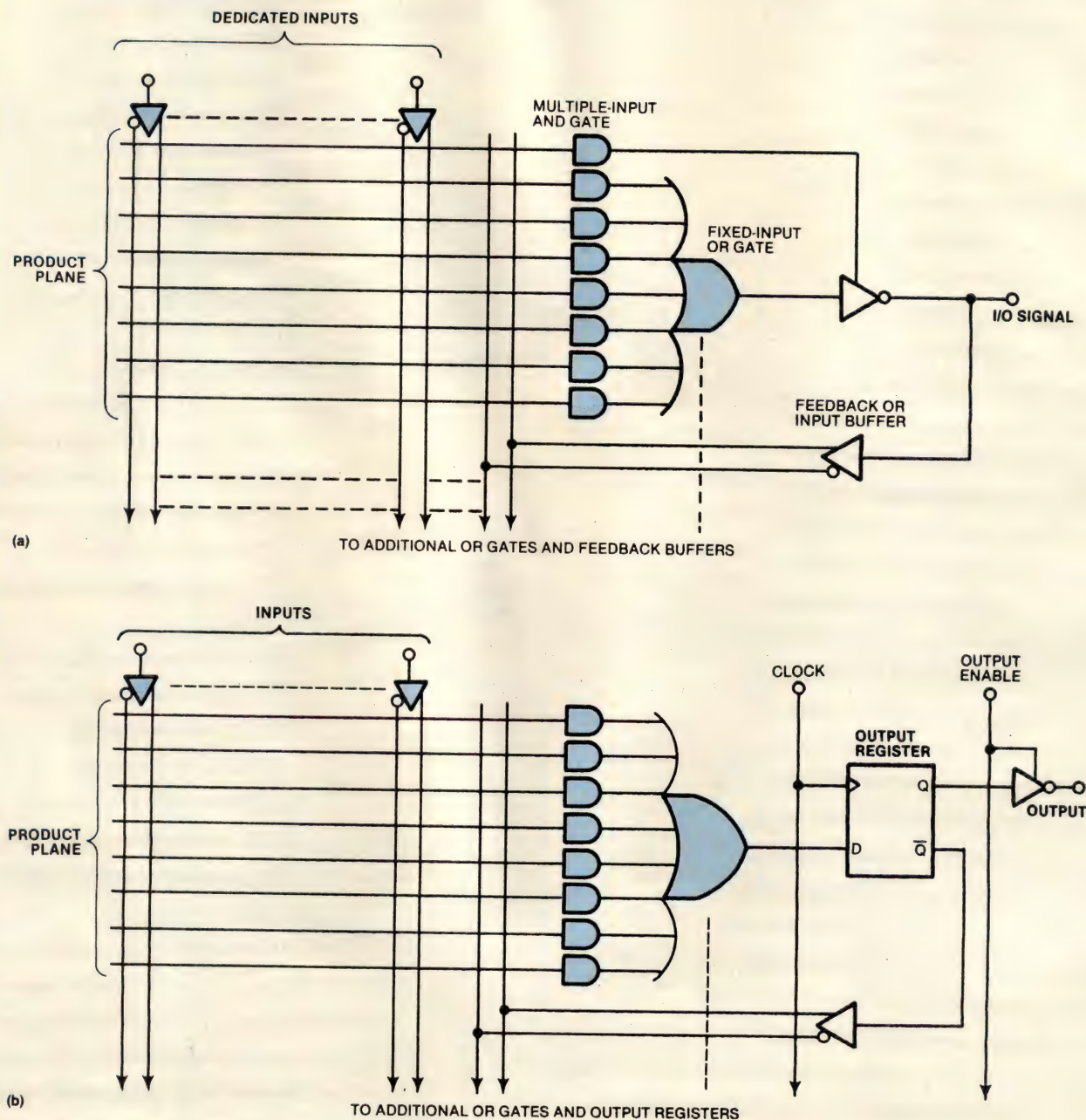
Unlike PROMs, though, FPLAs don't need a product term for each possible input-code combination. Signetics's 82S100 FPLA (dubbed the 93459 by second source Fairchild), for example, includes 16 input terms and provides 48 product

terms (an equivalent PROM requires 64k product terms to decode all possible data addresses).

Housed in a 28-pin DIP, the device furnishes eight output terms, each with independently programmable output polarity. Array outputs consist of true or complemented sums of as many as 48 products;

each product depends on combinations of inverted and noninverted input signals. The \$9.56 (100, plastic package) array features 50-nsec input-to-output delay and dissipates 600 mW.

More refined FPLAs, such as Signetics's 82S153 (second-sourced by Harris and designated the



Programmable-array-logic ICs (PALs) come in asynchronous (a) and synchronous (b) versions. The devices include programmable AND matrices but employ fixed-input OR gates for short propagation delays and simplified programming. Mask options determine the distribution of PAL product terms among output summing buffers.



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HPL-77153 by that firm), depart from PROM-derived architectures and more directly address the needs of logic circuits. The 20-pin 82S153 includes only eight inputs and 32 product terms and thus proves easier to apply and program than the larger 82S100. Moreover, its 10 output terms feed back into its product array, so outputs can depend on multiple sums of product strings (provided that the systems employing the array can tolerate the extended propagation times that such feedback paths entail).

In addition, you can use the feedback terms to form latches. The \$5.28 (100, plastic) 82S153 also includes independent product terms for control of each output-enable signal. (*Ed Note: For a design example involving the 82S153 and an illustration of programmable logic design techniques, see the Design Idea on pg 283.*)

PALs simplify designs

Further easing device programming, programmable-array-logic ICs (PALs) employ user-definable product matrices and fixed sum planes. They were developed by Monolithic Memories Inc and are second-sourced by National Semiconductor, Advanced Micro Devices and Texas Instruments. (Motorola plans to introduce PALs later this year; Harris produces functional equivalents to some PALs.)

The single-matrix devices furnish less flexibility than do multiple-plane FPLAs, but their relative simplicity results in lower power consumption. Furthermore, their lack of an OR-plane fuse matrix contributes to lower parasitic capacitances and thus entails higher operating speeds. PALs also require smaller dice than equivalent 2- and 3-level devices and therefore cost less.

Informed selection

To determine whether your designs can tolerate the fixed sum arrays that PALs provide, you must

determine how critical arbitrarily assignable sum terms are to your application. MMI strategic marketing manager Shlomo Wasser estimates that only 10 to 20% of all designs require programmable assignment of product terms to specific output lines. Most applications involve sum terms that depend only on small groups of product signals, so properly selected PALs provide adequate flexibility. Typical 20-pin-PAL OR-plane assignments range from one output term fed by 16 product terms (PAL16C1) to eight OR outputs each fed by seven products (PAL16L8); 24-pin devices furnish as many as 10 3-product outputs (PAL20L10).

Because PAL output assignments remain mask dependent, PAL application involves informed selection rather than output-plane programming. Thus, PAL families must contain more devices than product lines offered by FPLA vendors. Wasser points out, however, that to bring PAL universality closer to that of FPLAs, MMI is developing methods for providing single-level components with some OR-plane flexibility—without sacrificing speed, power consumption or cost.

To give PAL users maximum flexibility, the range of available single-level devices includes numerous input, output and OR-assignment variations. The PAL16L8, for example, has 10 dedicated inputs, two dedicated outputs and six I/O pins. Each output OR gate connects to seven product terms, and each output buffer has its own enable product term.

Bidirectional pins serve either as I/O bus connections or as dedicated outputs with feedback. The device provides 35-nsec max propagation delay and consumes 550 mW. An active - HIGH version, the PAL16H8, furnishes noninverted outputs.

Adding one product term to each of the PAL16L8's output lines, Advanced Micro Devices's

PAL16LD8 and PA16HD8 provide dedicated output pins. The product terms used for output enabling in the standard configurations feed directly into the modified components' output buffers, so the modified parts furnish 10 dedicated inputs, two dedicated outputs without feedback and six dedicated outputs with feedback.

To further increase the versatility of PAL16L8-type devices, Harris offers its HPL-77216/16P8. This array furnishes programmable output polarity using XOR gates in the eight output lines and eight additional array fuses. Says Harris's Helsby, designs rarely require signals of one polarity, so the HPL-77216/16P8 eliminates the need for external inverters.

In addition to manufacturing programmable-polarity parts, Harris intends to introduce proprietary designs that furnish reassigned product distributions. Future offerings will include mask options allowing one or two outputs to connect to more than seven product terms.

For applications involving synchronous, sequential circuits, several PAL versions include output registers. The PAL16R8, for instance, furnishes eight inputs, eight output terms each driven by eight product terms, and eight D-type output registers each with feedback. This array provides common clock and output-enable lines and features 25-nsec max clock-to-output delay.

Other latched-output (registered) PALs include the PAL16R6, with two asynchronous bidirectional outputs, and the PAL16R4, with four synchronous lines and four registered outputs. And to suit arithmetic applications, MMI and National offer the PAL16X4, which provides XOR gates between its sum terms and output registers. This part also features input networks that accommodate input/feedback operations, including $I+F$, $\bar{I}+\bar{F}$ ($\bar{I}\bar{F}$), $\bar{I}+F$ and $I+\bar{F}$.

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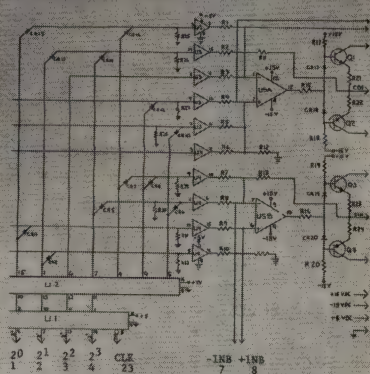


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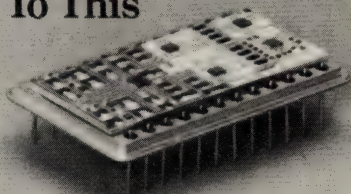
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Programmable logic like the foregoing parts allows an element of design interactivity that other customizable logic forms don't permit, says AMD bipolar applications engineer Warren Miller. Gate-array designers, for example, can pass through only one of the design iterations because of long prototyping times and high engineering and fabrication costs. Programmable devices, however, allow you to create hardware in the same way that programmers with emulation tools write software: You can pass programmable-logic-based designs through an infinite series of revisions, testing and modifying circuits until they perform properly. Moreover, you can reprogram array-device pinouts during pc-board layout cycles to effect the best compromise between IC and packaging designs.

Programmable logic further improves design cycles by eliminating layers of abstraction between prototypes and production devices. Gate-array designers frequently rely heavily on computer-aided simulation—a technique that generally provides accurate first-order performance analyses but often doesn't gauge second-order characteristics such as critical-path delays, environmental phenomena and in-circuit operation. In addition, programmable-logic devices entail fixed, known production costs. Thus, designers who employ them despite unit costs that typically exceed those of semicustom or custom components buy insurance against unforeseen engineering expenses.

Array logic without fuses

Despite the insurance they provide, field-programmable devices still entail production costs that prohibit their use in many high-volume applications. However, designers who wish to employ them for prototyping and test-marketing purposes might soon have a viable means of translating initial designs

to low-cost volume-production components: As programmable-logic complexity increases, the price difference between field-definable chips and their mask-programmed counterparts increases.

Currently, mask-defined substitutes exist for several PALs, but such hard-array-logic components (HALs) cost only 30% less than fuse-based ICs. As a result, users must commit to large production volumes before they can recover their mask-generation expenses.

The large PALs that will emerge over the next few years, however, will require so much on-chip programming circuitry that they will cost as much as 70% more than their HAL counterparts. Thus, complex PALs will be relegated primarily to prototyping functions, sharing the same relationship with HALs that piggyback - EPROM single-chip μ Cs share with masked-ROM production versions.

As a first step toward creating array-logic components that suit high-volume production, Motorola Inc has introduced a line of HALs employing what memory and LSI product-planning manager John Carey terms minimum standard-diffusion masks. By optimizing the devices for mask-level programmability, the firm claims to have decreased the components' die areas to half those required by fuse-programmable chips.

Motorola has not yet set prices for the devices, but Carey believes that the HALs will provide an economical alternative to gate arrays in applications requiring fast prototyping and low engineering costs. Initial product offerings include mask-programmable replacements for 16L8, 16R4, 16R6 and 16R8 PALs.

Testability poses problems

Before array-logic devices—both programmable and mask defined—become viable in high-volume production, however, several difficulties must be resolved. For instance,

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Technology

PAL, HAL and FPLA users must learn to develop comprehensive test patterns that exercise all phases of device activity, and fuse-logic-programmer vendors must instill their instruments with the ability to gauge device operation as well as facilities to verify fuse patterns. Moreover, programmable-logic manufacturers must devise methods for performing wafer-level device-programmability and -functionality analyses.

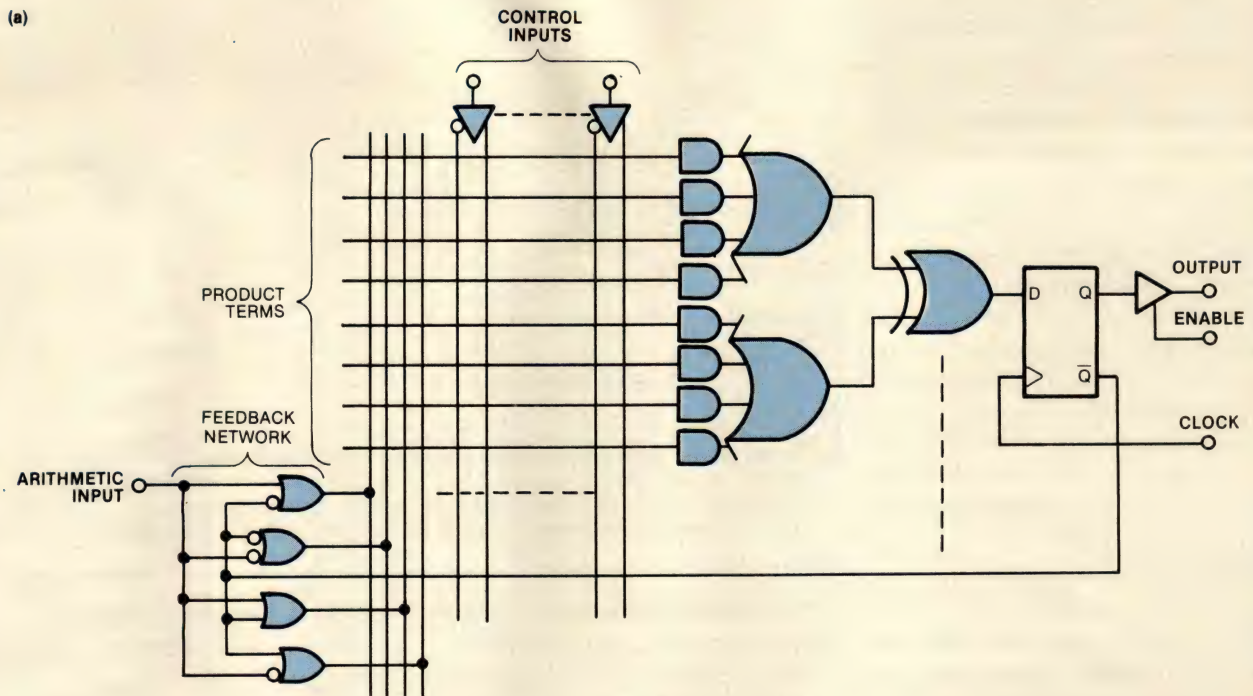
One method of increasing device yields involves designing circuitry into array chips to allow testing before packaging and programming. AMD, for example, adds test rows and columns to its PALs' fuse arrays and thus can gauge device programmability. Harris employs a similar scheme to provide prepackaging function verification as well as programmability analysis; an on-chip test circuit that remains intact after fuse programming verifies ac and dc parametric performance at the wafer level and assists in field-failure analyses.

Such circuit pretestability reduces the probability of discovering malfunctioning devices in assembled systems, but users must also be able to verify that programmed devices operate as designed before installing them on pc boards. Such functional analyses require a set of test vectors that completely exercise devices and a test fixture that compares test data with prestored ideal values.

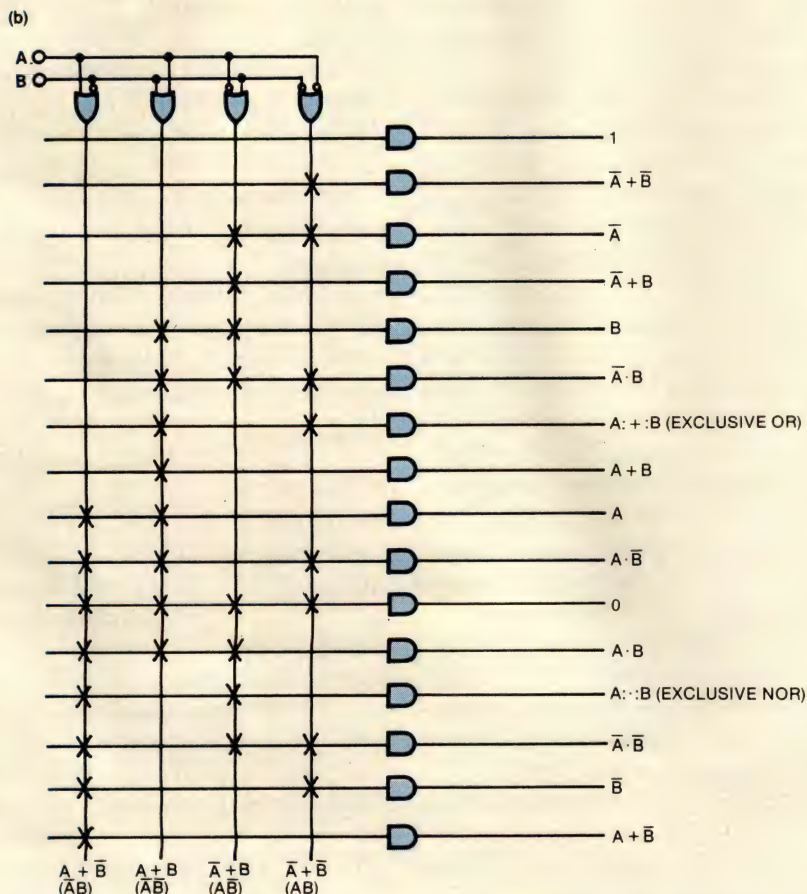
For testing asynchronous parts, Stag Microsystems's (Sunnyvale, CA) Model PPX programmer uses a self-learning algorithm to develop PAL and FPLA test patterns. The instrument interrogates a known-good array by stepping through all possible input patterns and storing the codes that cause output changes. It then uses those patterns to test unknown devices; typical tests require less than 1 sec.

Using a signature-analysis technique, Data I/O's (Redmond, WA) Model 29A programmer tests a

Technology Update



Suiting arithmetic applications, registered PALs with XOR gates (a) and combinatorial feedback allow you to construct programmable arithmetic and logic units (ALUs). By connecting combinations of the four feedback terms to product AND gates (b), you can generate 16 2-variable logical identities.



previously verified part with a randomly selected input-pattern set and uses the results to gauge unknown components. The algorithm relies on the assumption that device defects cause catastrophic failures and require only a limited number of vectors for detection.

Testing sequential, registered components proves far more difficult than analyzing asynchronous devices. Synchronous parts often possess states that can't be entered or departed in response to external stimuli and thus pose potential problems during system power-up. To verify that you can always drive sequential parts into known states, you must ensure that no output state exists that can't be reset. Device test vectors, therefore, must interrogate every register condition.

To allow testing of inaccessible states, AMD PALs include register-preload circuitry. Active during fuse-verify programming modes,

Technology Update

this preload feature permits you to set devices to states that can't be triggered externally. With a properly devised test routine, then, you can guarantee that sequential parts won't latch in nonresettable states. The feature operates only while devices reside in a programmer, though; to add in-circuit preloading or reset capabilities, you must use a properly configured product term.

For further fault isolation, most vendors are working on grading programs and algorithmic test-pattern generators. To test HALs before shipment, for example, MMI employs test-grading software that interactively creates input patterns until the test-vector set becomes sufficiently extensive to change the states of all array nodes.

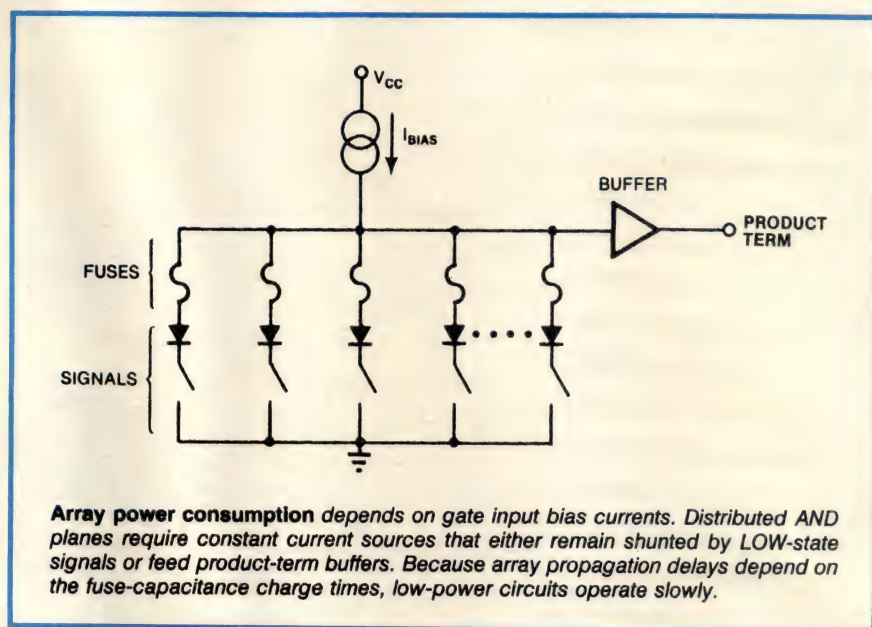
The program begins with the simulation table generated by PALASM—a FORTRAN-based PAL-development package that converts Boolean equations to fuse-program data—and then gauges the effectiveness of each pattern by monitoring array states.

Harris also plans to offer an automatic test-vector-generation software package. Available later this year as a part of the firm's HELP (Harris Enhanced Logic Programming) system, the program will generate an optimized set of input patterns for comprehensive device analysis.

The software will work in conjunction with HELP's fuse-pattern - creation and logic-minimization programs and will design test sequences for PAL and FPLA device families. You can use HELP from a remote terminal connected by phone to Harris's computer facilities; the software accepts design data in Boolean form and selects the best device for circuit implementation using user-defined circuit-speed parameters.

Power consumption must drop

In addition to device-testing difficulties, high power consumption stands in the way of widespread



programmable-logic use. Designed originally as replacements for TTL devices, PALs and FPLAs typically require as much power as two or three MSI STTL parts or as many as 15 LSTTL components. Emerging high-density applications, however, can't always tolerate the chips' 500- to 600-mW/package dissipation levels.

Unfortunately, array-logic devices don't lend themselves to low-power implementations. Distributed-input gates require a constant input bias, and to maintain propagation delay less than 500 nsec despite high parasitic capacitances, fuse arrays must draw at least 60 mA. Thus, even CMOS components require at least 300 mW; only array input buffers, output drivers and registers benefit from CMOS's inherently low power consumption.

Suiting low-power applications that don't require high-speed devices are MMI's half- and quarter-power PALs. Identified by -2 and -4 suffixes, respectively, these components operate with reduced array bias currents and increased propagation delays compared with their standard-power counterparts. The firm also intends to introduce PALs that furnish increased speed-power products and thus can achieve better than 50-nsec performance at

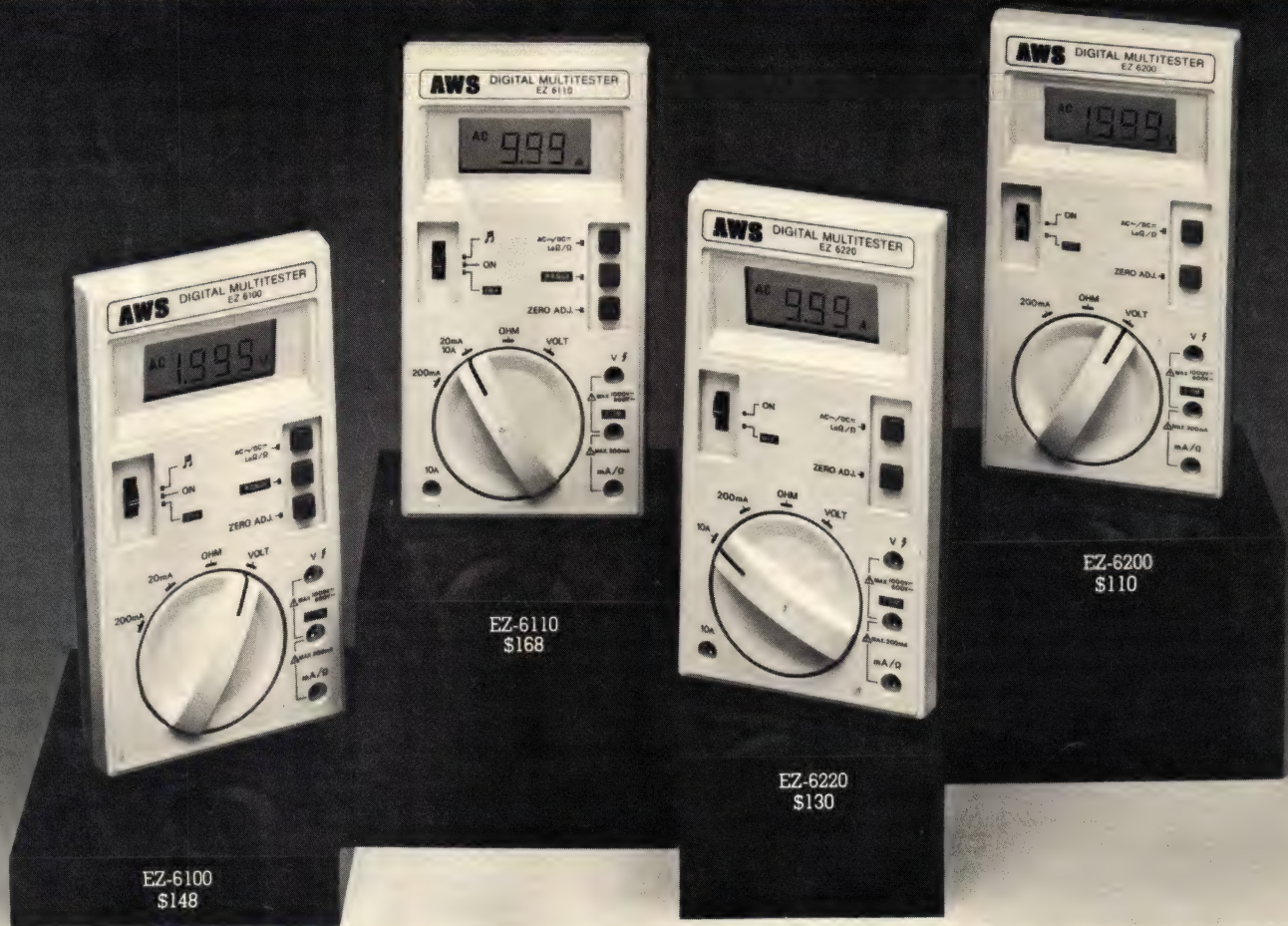
low power levels.

Several other vendors are examining ways to decrease their products' power consumption. Explains Harris senior applications engineer Steve Bennett, low-power CMOS registered parts present little fabrication difficulty. The devices' clock inputs can strobe fuse-array power connections and thereby allow the circuits to draw current only when updating their outputs.

Such powered-down parts, however, operate more slowly than constantly energized arrays because fuse matrices don't become active immediately upon receiving power. Similarly, asynchronous arrays could employ edge detectors that strobe fuse matrices only when input signals change, but such devices would operate no faster than bipolar arrays with equivalent power requirements.

Conceivably, HALs will become the first array-logic devices to employ CMOS processes. Mask-programmed arrays possess less capacitance than fuse-defined circuits and thus operate with higher speed-power products. Moreover, HALs compete more directly with gate arrays than do fuse-programmable circuits, so recent advances in low-power, high-speed gate-array

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Low Power Ω:		Low Power Ω:	
0-2000KΩ	4-Autoranges	0-2000KΩ	4-Autoranges
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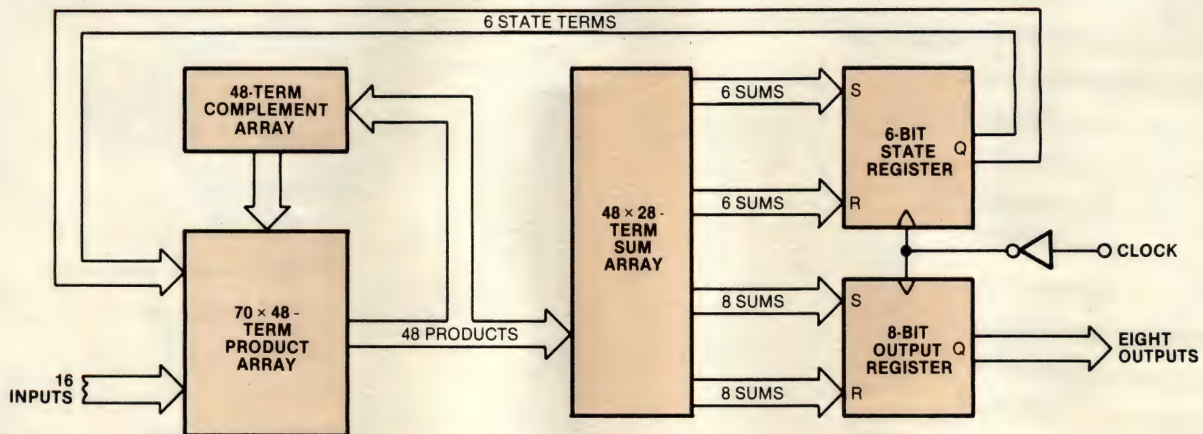
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Technology Update



Two versions of a fully implemented Mealy state machine, Signetics's 82S104A and 82S105A programmable sequencers suit sequential-controller applications. They generate new output states that depend on input conditions and the values stored in a 6-bit feedback register.

technology will force manufacturers of mask-programmable array logic to develop viable CMOS devices.

ECL arrays coming

At the opposite end of the speed-power spectrum, manufacturers continue to strive for increased device speeds regardless of operating power. Both AMD and National offer oxide-isolated TTL PALs that furnish 25-nsec typ propagation delays. Bearing -A suffixes, these devices spec 12-nsec typ delay and 20-nsec max clock-to-output delay in registered versions; they draw 180 mA max.

Signetics has also turned to process refinements to increase the speeds of its IFL devices. The first beneficiaries of improved fabrication technology, the 82S104A and 82S105A field-programmable logic sequencers (FPLSs) operate at clock rates to 20 MHz—nearly twice the speed of older 82S104 and 82S105 versions.

The \$22.40 (100) devices represent fully implemented Mealy state machines—circuits in which the state occurring after each clock cycle depends on input stimuli and the state immediately preceding the clock transition. They provide 48 product terms, 28 sum terms, eight output registers, six feedback

registers and a 48-term product-plane inverter.

The 82S104A furnishes open-collector outputs; the 82S105A has 3-state outputs. Both devices include registers that dynamically switch among JK, D and toggle modes.

Despite advances in saturating-logic technologies, many of the high-speed circuits that originally employed programmable-array devices are reaching speed levels that require ECL components. And although no ECL programmable-logic arrays currently exist, developments in ECL PROM technology indicate the feasibility of ECL PALs and FPLAs with 5-nsec propagation delays, and products will begin emerging this year.

National Semiconductor bipolar- μ P marketing manager Dave Uimari claims that ECL fuse-programmable arrays will enjoy wide use largely because of the lack of development of 10K and 100K ECL standard-component families. As a result, ECL programmable components will probably find use in a larger percentage of high-speed applications than TTL-compatible devices do in medium-performance circuits.

Developed specifically for main-frame-computer applications, Fair-

child's 100459 promises to be the first commercially available ECL FPLA. To be formally announced later this year, it features 16 inputs, 48 product terms and eight sum terms that feed latches with transparent and clocked modes.

The chip also includes a maintenance circuit that allows you to read serially the states of nine internal nodes, the system clock and the output of an open- and short-circuit detector. The array specs 4-nsec input-to-output time and requires 8 nsec for a complete clock cycle.

Fairchild also intends to apply its vertical-fuse PROM technology to FPLAs. Currently incorporated in the firm's 16k- and 8k-bit memories, the vertical fuses require considerably less die area than conventional lateral fuses and thus allow smaller, faster parts.

However, vertical fuses require more programming circuitry than do lateral fuses. Thus, the vertical-fuse technology best suits large arrays in which the fuses' extra programming circuitry requires less silicon than lateral fuses would.

Fundamental changes

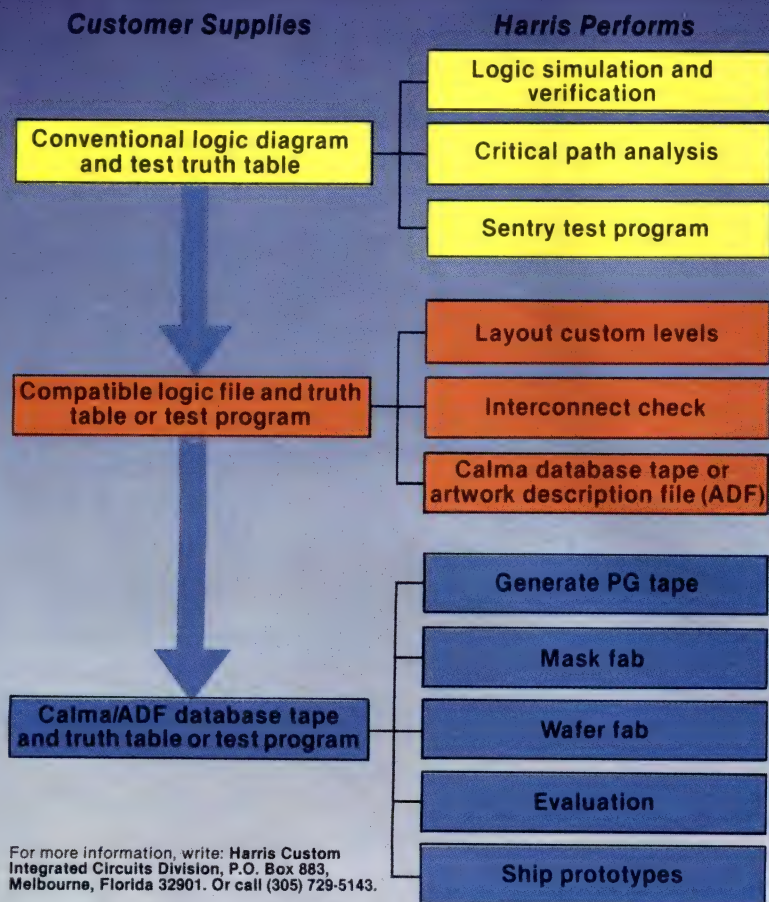
As programmable arrays become faster and denser, they will also change fundamentally to better suit emerging applications. For exam-

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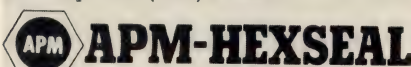
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Technology Update

For more information...

For more information on the field-programmable logic circuits described in this article, contact the following manufacturers directly or circle the appropriate numbers on the Information Retrieval Service card.

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Texas Instruments Inc
Box 225012
Dallas, TX 75265
Phone local office
Circle No 742

ple, synchronous parts will soon include input latches that will allow them to work on asynchronous buses while avoiding metastable states. Moreover, suggests Signetics IFL marketing manager Geoff Dyer, programmable state machines will acquire more intelligence; next-generation devices will include such features as on-board RAM and control circuits, which will make them applicable to a broader range of applications.

Higher density parts will also undergo architectural changes to overcome the limits of programmable circuits. Currently available programmable arrays exhibit global conductivity for all signals within each internal matrix. But the cost of allowing every input signal to connect to every available sum or product term manifests itself in increased die sizes, high power consumption and long propagation delays. Therefore, claims MMI's Wasser, future high-density devices will incorporate islands of local conductivity interconnected by a few global buses.

In addition, because software developments continue to lag semiconductor processing technologies, array logic will find its way into increasing numbers of VLSI cir-

cuits. Programs that design fuse patterns for distributed-input gates operate far more efficiently than do placement and routing algorithms for arrays with randomly distributed gates. To be more usable, then, ICs incorporating many thousands of gates might be forced to assume regular, matrix-like structures.

In one sense, such structured ICs already exist. The first silicon compilers—programs that convert truth tables or logic equations directly to silicon—employ regular array-logic structures as their basic building blocks. The cell designs provide simple expandability and reconfigurability and can stack in endless combinations to implement sums-of-products or products-of-sums logic strings.

Such silicon compilers have already borne their first commercial fruit: Seeq Technology Inc's (San Jose, CA) recently introduced single-chip Ethernet controller (EDN, November 10, pg 82) employs array-logic structures extensively and as a result underwent extremely rapid design. **EDN**

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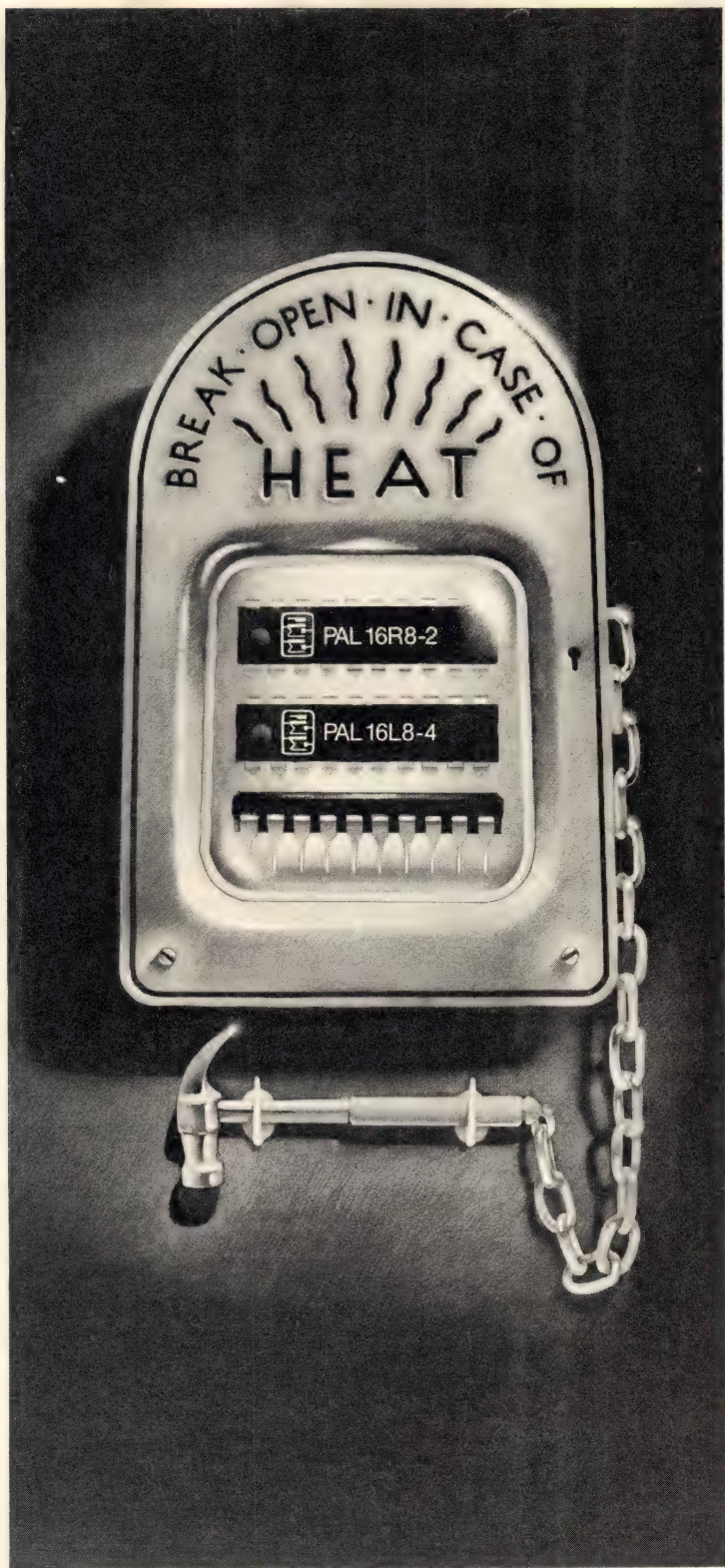
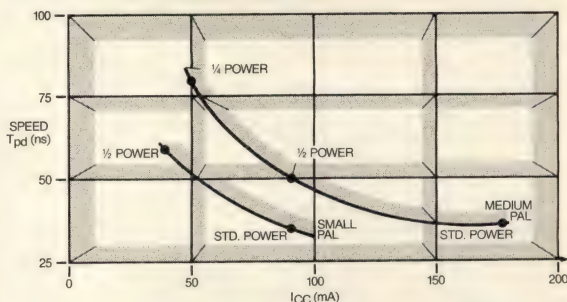


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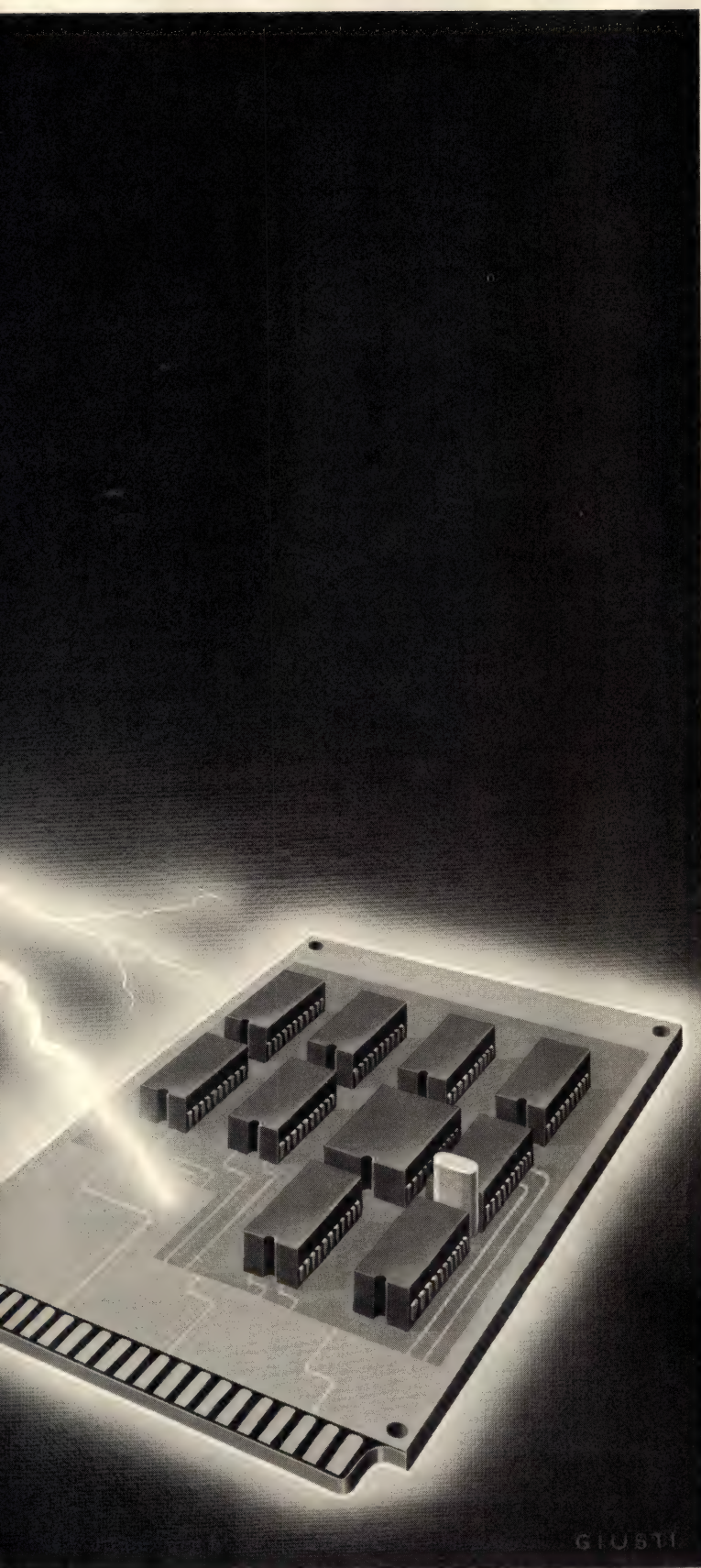
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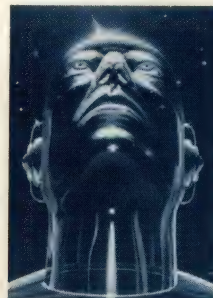
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Technology Update

What is today's designer like? EDN polls its readers to find out

Paul G Schreier, Editor

As electronic technology changes, so does the role of the design engineer. To gain a better understanding of that role and thereby better serve your needs, EDN last fall conducted an extensive survey of its readership. The results of the poll, appearing in more than 160 pages of computer printout and summarized here, are interesting.

Basic facts

Questionnaires went to 2000 randomly selected readers, 946 of whom responded. This 47.3% response rate is considered quite good for this type of survey and permits statistically significant conclusions.

As Fig 1 shows, EDN readers' ages vary widely; the median is 39, indicating that a career in electronics engineering doesn't necessarily end at the magic age of 40.

As for educational background, 1.9% of you have no college experience, 16% have no college degree, 48.9% have an undergraduate degree, 18.9% have done

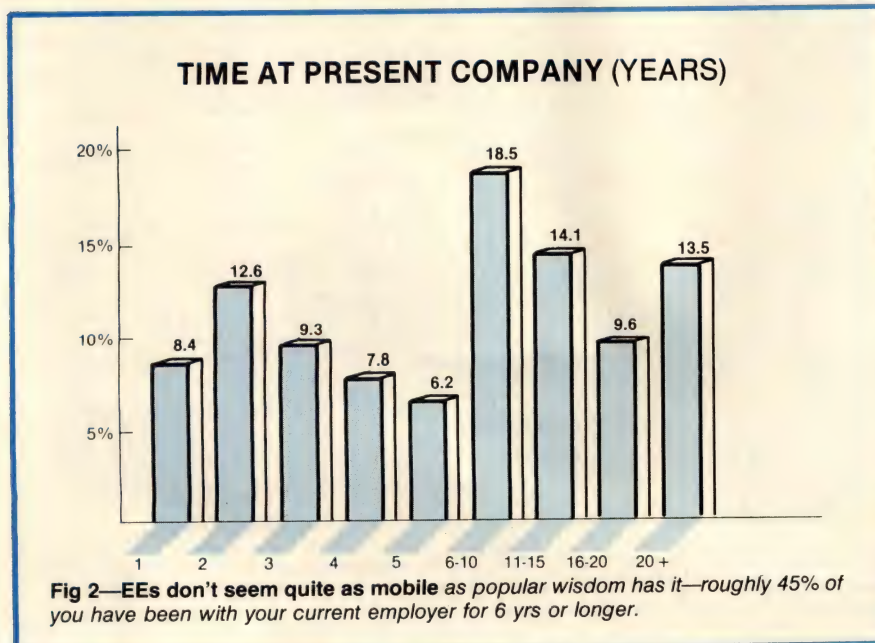
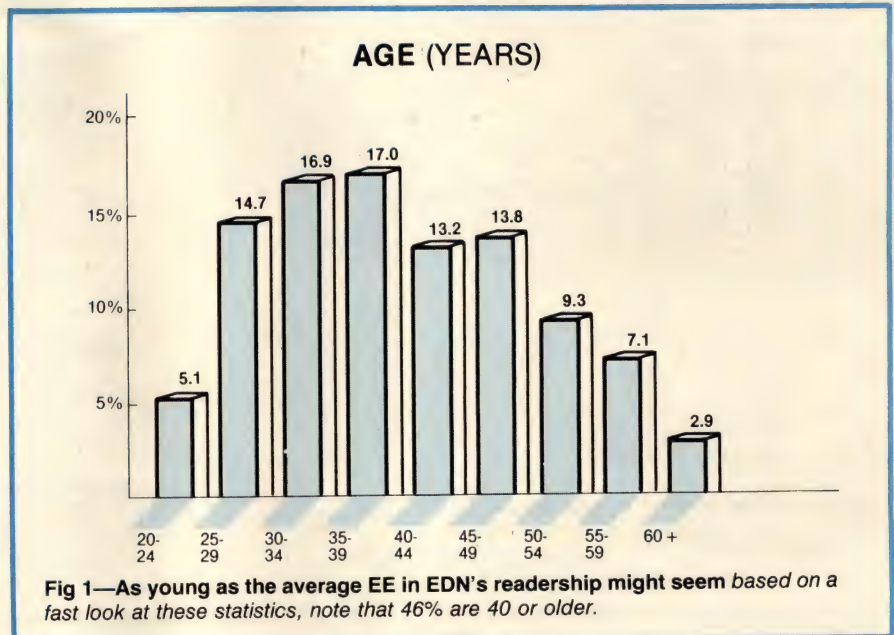
postgraduate work, 21.8% have earned an MS degree, 1.5% have an MBA and 4.5% have a PhD (multiple replies were accepted). To further your education, 21.5% of you attend evening programs and 13.7% participate in daytime programs on a part-time basis.

Length of employment at current

employer (Fig 2) also shows some interesting results. Average length of service for the EDN reader is 9.9 yrs—a figure that seems to go against the image of the job-hopping EE. In fact, 55.7% of you have been with the same company for 6 yrs or more.

Your duties and responsibilities can be examined in several ways. Considered in terms of job titles (Fig 3), for example, you fall under quite a variety of headings.

However, considering title inflation and the fact that a title can have different meanings at different firms, we followed up our job-title query with several questions. In one, 28.2% of the respondents identified themselves as performing primarily management functions; 68.1% are involved primarily in engineering. And of those engineers, the vast majority—78%—listed design and development engineering as their primary job function; 9.2% cited engineering services, 8.6% indicated manufacturing and production engineering and 4.2% listed their primary



Technology Update

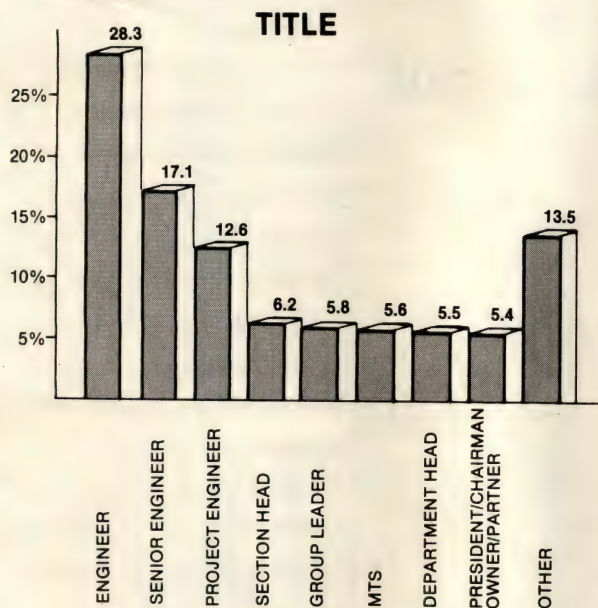


Fig 3—Titles abound in electronics. EDN readers in the Other category have titles such as VP, VP for engineering, technical director, chief engineer, principal engineer, research director, consultant, scientist and physicist.

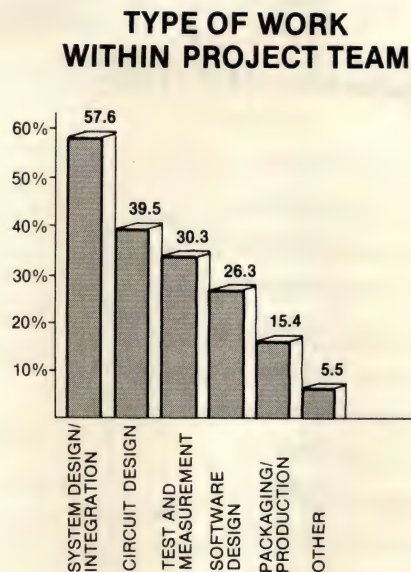


Fig 4—Although system design/integration dominates EDN readers' type of work, this function encompasses many aspects, depending on end product, level of integration and involvement in other activities. (Multiple responses were accepted.)

function as basic research.

A breakdown of duties by technical area within a project team appears in Fig 4. System design/integration leads in responses; the rapidly growing area of software design also scores well.

When asked, "What is the product or service that is your own work," you provide a large variety of answers. The most often cited categories include test and measurement, communications systems and industrial controls (Fig 5). The

plants where you work produce these same types of products in roughly the same scale; the largest discrepancy is in test and measurement: As you might expect, many designers are involved in developing custom test systems for their

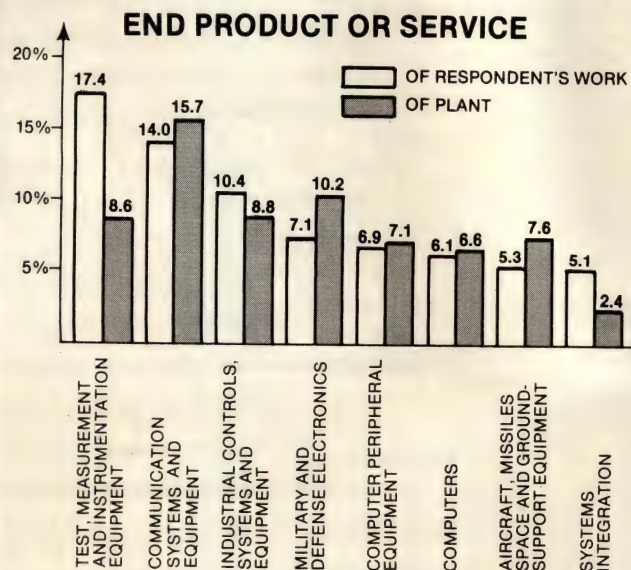


Fig 5—A fairly high correlation exists between your plant's end product and your own work. All categories polling less than 5% are omitted except for system integration.

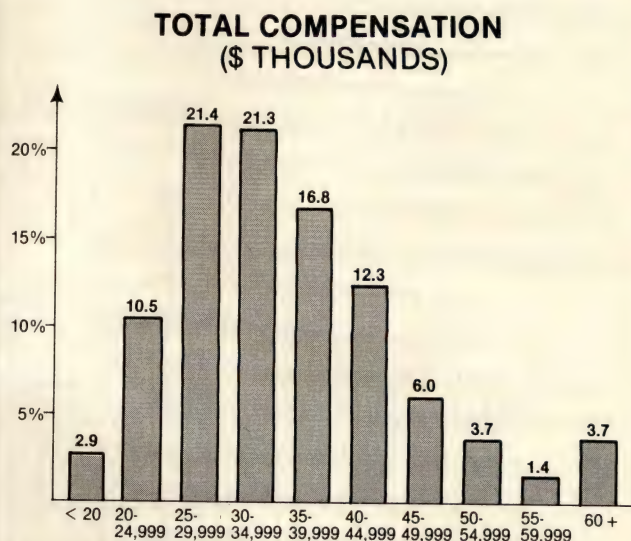
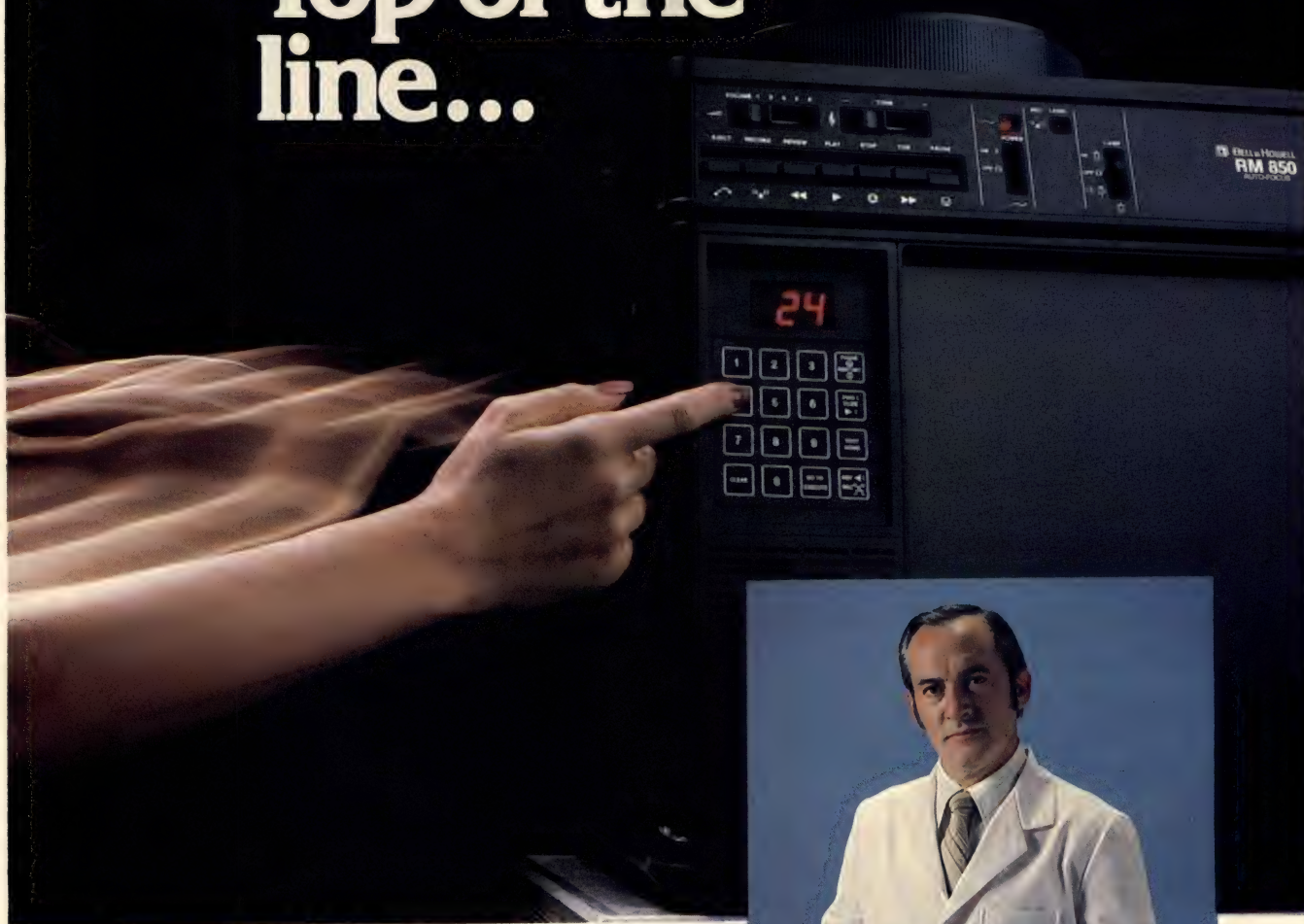


Fig 6—Although a median income of \$33,550 was calculated in the reader profile, a surprisingly large number of you earn more than \$60,000.

Top of the line...



That's Topflight territory.



The designers at Bell & Howell had but one directive concerning their new Ring-master® II Sound/Slide projector line:

"Make it the Best!"

The Bell & Howell Model 850 is the industry's first random access, microprocessor-controlled sound/slide programmable projector, and it'll do everything . . . including think!

So, for the Top of the Line, what membrane touch switch do you suppose they'd specify?

Topflight's Membrane Switch Division has created the "top-of-the-line" touch switch as interface to these systems.

But, then again, Top-of-the-Line has always been Topflight territory in switches, EMI shields, flexible printed circuitry, breakthrough graphics ideas.

Top-of-the-Line reliability.
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And Topflight's Top-of-the-Line Territory is being explored further every day . . . for new ideas, new designs, new and better ways of doing

things for the industrial designer who has to . . .

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Technology Update

facilities.

The composite reader's plant employs 183 engineering or scientific personnel; the largest group of plants are facilities with more than 1000 such personnel.

The bottom line

How about earnings? Total compensation, including base salary and bonuses, follows a bell-shaped curve whose median is \$33,550 (Fig 6). As expected, few of you earn less than \$20,000; a surprisingly large number (3.7%) are heavy hitters with incomes larger than \$60,000. When

AREA OF ACTIVITY

TOTAL COMPENSATION	TEST AND MEASUREMENT	SYSTEM DESIGN	CIRCUIT DESIGN	SOFTWARE DESIGN	PACKAGING AND PRODUCTION
< \$12,000	0.4%	0.8%	0.3%	1.3%	1.4%
\$12-14,999	—	0.2%	—	—	—
\$15-19,999	2.9%	2.1%	2.2%	2.5%	2.2%
\$20-24,999	12.4%	8.4%	13.3%	10.0%	16.5%
\$25-29,999	25.0%	17.8%	24.3%	23.0%	23.8%
\$30-34,999	23.3%	21.3%	20.2%	24.7%	22.3%
\$35-39,999	12.7%	17.4%	18.2%	15.5%	15.8%
\$40-44,999	12.4%	13.0%	11.9%	10.5%	5.0%
\$45-49,999	2.9%	7.5%	4.4%	4.6%	0.7%
\$50-54,999	3.3%	4.8%	1.9%	2.5%	3.6%
\$55-59,999	1.8%	2.1%	0.8%	2.1%	2.9%
\$60,000 +	2.9%	4.6%	2.5%	3.3%	5.8%
MEDIAN	\$31,950	\$34,800	\$32,450	\$32,650	\$31,300
COMPOSITE MEDIAN	\$33,550				

Fig 7—Median compensation ranks above the composite median income in only one area of technical activity—system design and integration—but Fig 4 shows that more of you fall into that category than any other.

EEs fare well in the engineering community

This article's study of EDN readers provides some indication of EEs' current status, but how does electronics engineering stack up against other engineering fields?

EEs are reasonably well off, according to the results of the Fox-Morris Personnel Consultants's 1982 study, as reported by *Recruiting Engineers and Computer Professionals* (a semimonthly newsletter produced by Cahners Publishing). Total demand for engineers, the Philadelphia-based firm reports, rose 8.1% from 1981 to 1982, while the demand for EEs jumped 12.4%. Next in demand were control/instrumentation (11.1%), mechanical (9.6%), petroleum (7.5%), aerospace (5.7%), energy (5.1%), research and test (4.6%), chemical (3.8%), industrial (3.3%) and metallurgical (2.3%) engineers.

The most sought-after engineers, notes the firm's president, Sanford Fox, are those with 2 to 5 yrs' experience—they offer "proven talent at reasonable salary expectations." At the senior engineering level,

demand continues strong—in contrast to what's occurring in nonengineering fields—because experienced line and middle-management engineers get called upon to replace those tapped for upper-management posts.

EEs also fare well in terms of salary compared with other engineering fields; the nearby table lists the 10 best-paying fields by salary.

Keep one fact in mind when evaluating the foregoing data: Agency-supplied figures might be somewhat inflated. Newsletter editor Beth Clark Pape points out that because agencies get a percentage commission, salaries negotiated by recruitment firms tend to be higher than those for engineers who negotiate privately. Furthermore, such figures are sometimes used as a marketing tool—artificially high numbers could more easily inspire people to seek new opportunities. Nonetheless, the figures do show the relative rankings of the various engineering fields.

1982 AVERAGE SALARY — TOP 10 ENGINEERING FIELDS

RECENT GRADUATES		2-5 YRS EXPERIENCE	MANAGEMENT LEVEL
1.	PETROLEUM \$24,380	PETROLEUM \$31,560	PETROLEUM \$46,860
2.	MECHANICAL \$22,400	ELECTRICAL/ELECTRONICS \$29,355	CONTROL/INSTRUMENTATION \$45,729
3.	CHEMICAL \$22,287	CONTROL/INSTRUMENTATION \$28,475	ELECTRICAL/ELECTRONICS \$45,213
4.	CONTROL/INSTRUMENTATION \$22,262	MECHANICAL \$28,289	MECHANICAL \$44,313
5.	ELECTRICAL/ELECTRONICS \$22,144	CHEMICAL \$28,075	CHEMICAL \$43,429
6.	MINING \$21,160	METALLURGICAL \$27,957	RESEARCH & TEST \$40,780
7.	ENERGY \$21,017	RESEARCH & TEST \$27,900	ENERGY \$40,429
8.	AEROSPACE \$21,016	AEROSPACE \$27,150	INDUSTRIAL \$39,250
9.	RESEARCH & TEST \$20,920	MINING \$27,120	AEROSPACE \$39,167
10.	METALLURGICAL \$20,671	ENERGY \$26,814	MINING \$39,033

Compared with salaries in other fields of engineering, those for EEs stand reasonably high. In fact, they consistently trail those of only one discipline—petroleum engineering.

Technology

broken down by job function, the study results show that managers have a median income of \$40,400; engineers, \$31,850.

How does compensation vary with discipline within electronics engineering? As **Fig 7** shows, median figures for all the disciplines lie within 7% of the composite median; no single area seems to pay particularly high or low. The lowest figure (\$31,300) is for packaging and production engineers; the highest (\$34,800) is for system design. (For a look at how EE salaries compare with those of other engineering disciplines, see **box**, "EEs fare well in the engineering community.")

What role does the size of technical staff play in compensation? Do larger firms pay better or worse than smaller companies? In terms of pure compensation—ignoring such items as stock options or other growth-oriented inducements that smaller companies offer—it seems that larger firms do pay somewhat better—but still only 3.2% above the composite median of \$33,550.

Specifically, firms with 10 or fewer technical staff members pay an average of \$32,750; those with 11 to 99 people, \$31,850; those with 100 to 499, \$33,850; and those with 500 or more, \$34,650.

A good year ahead?

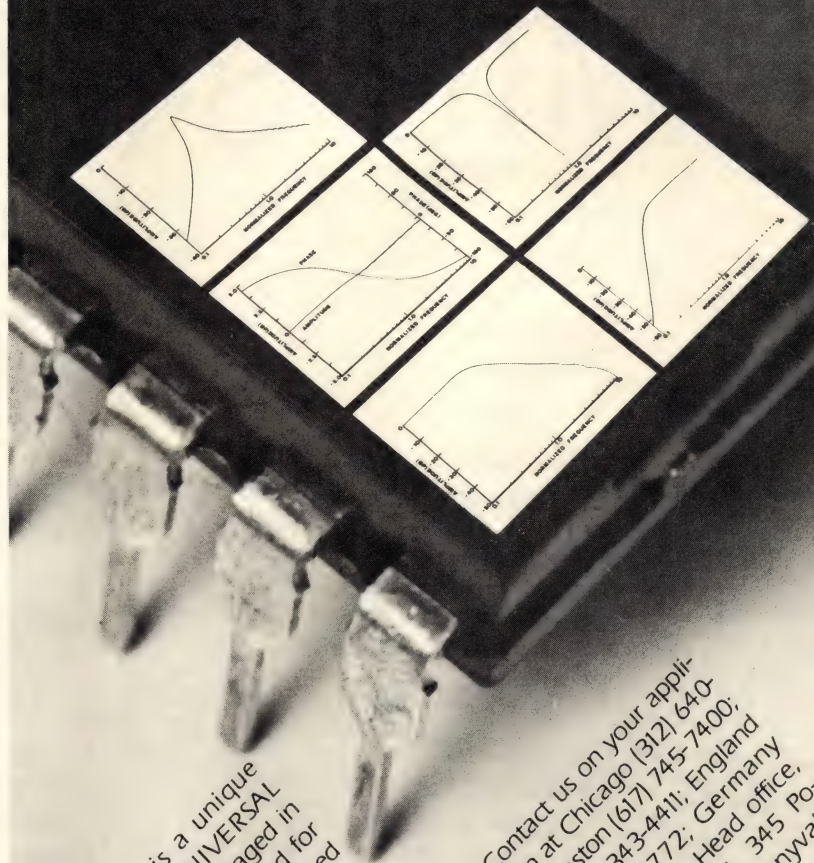
Finally, what do you see ahead? You expect your increase in total compensation in the next year to be an average of 11.2%. And when asked to choose from a list of the fields in which you expect your companies' involvement to increase, you make the largest number of positive responses for the fields of military and defense (50.4%), industrial controls (40.3%) and consumer products (33.4%).

EDN

Article Interest Quotient
(Circle One)

High 503 Medium 504 Low 505

UNIVERSAL ACTIVE FILTER...



The R5620 is a unique second order UNIVERSAL ACTIVE FILTER packaged in an 18 pin DIP. Designed for the novice and experienced filter user alike, the device provides for simple digital selection of frequency, Q and filter type without the need for any external components or the need to solve equations. This device is the latest in a series of standard products available from RETICON using Switched Capacitor Filter Technology.

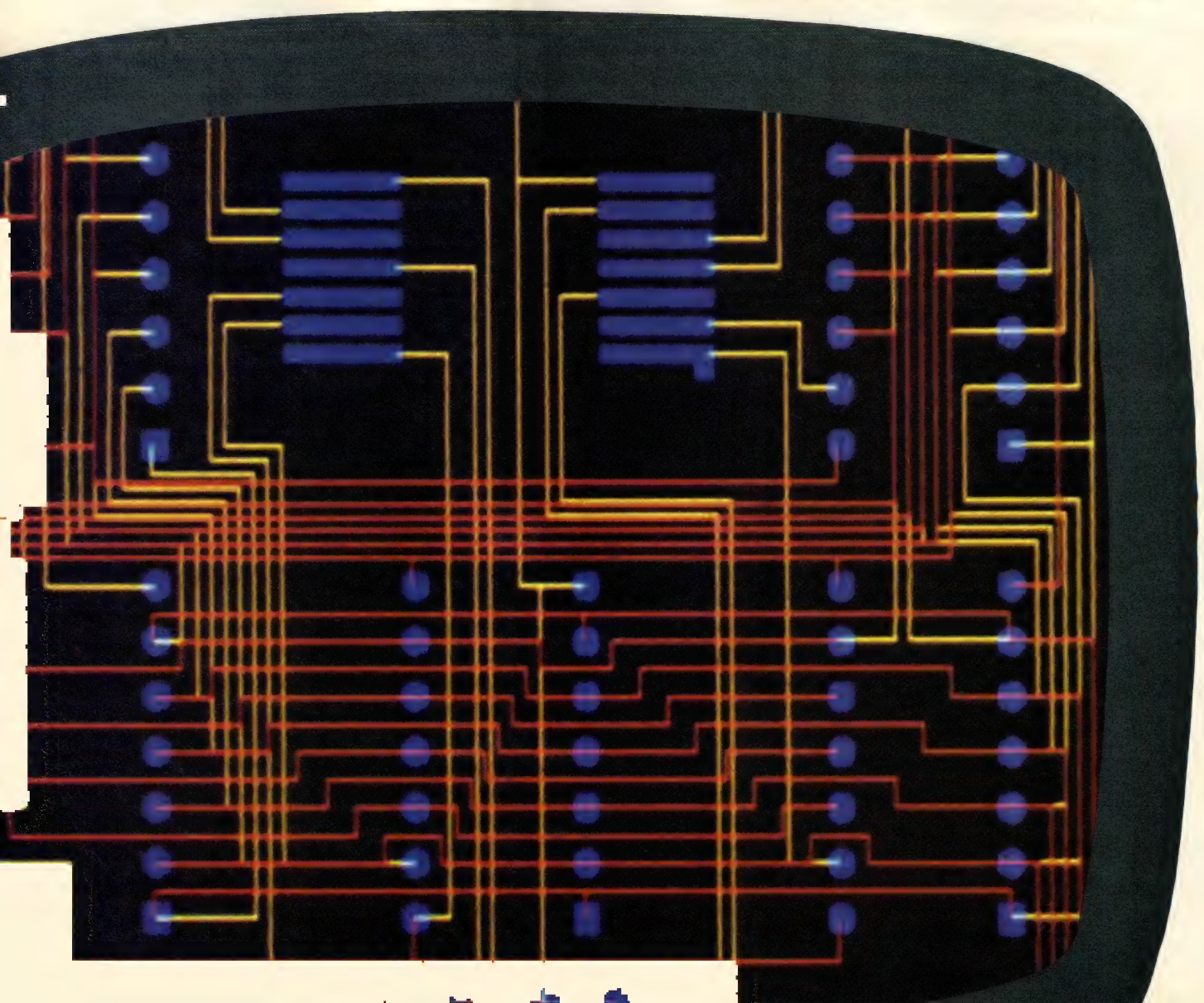
When looking for solutions to your filter needs, consult RETICON for off-the-shelf standard products or custom design and manufacturing.

Contact us on your application at Chicago (312) 640-7713, Boston (617) 745-7400, Japan 03-343-4411, England (0734) 790772, Germany (089) 918-060. Head office, EG&G RETICON, 345 Potrero Avenue, Sunnyvale, California 94086. Telephone (408) 738-4266.



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All the hardware integration work needed for mechanical engineering, PC board, architectural design, and VLSI CAD/CAM applications has been done for you. Every system comes complete with VAX, MARQUIS, tablet, puck, keyboard, high-resolution raster scan monitor, and, of course, service, support and training are available.

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CIRCLE NO 53

Autonulling and autoleveling circuits simplify analyzer distortion measurements

Automatic frequency nulling and level setting furnish no-hands operation of the 5-Hz to 1-MHz Model 6900 distortion analyzer. To measure total harmonic distortion (from 0.01 to 19.9% with 0.001% resolution) at input levels spanning 100 mV to 30V rms, you simply connect the source to the instrument's input terminals. The unit

also doubles as an ac voltmeter; measurement results appear on an autoranging digital display.

Three filter networks (two twin Ts and a bridged T) use photosensitive resistors as frequency-tuning elements to provide the automatic nulling capability. The frequency of the signal being measured automatically determines which network to

select. In-phase and quadrature-feedback control amplifiers provide automatic frequency tracking by maintaining the photoresistors at the value required to null the fundamental signal.

A 2-stage input amplifier combines with an output amplifier to provide the \$1995 analyzer's autoleveling capability. A sense amplifier varies the input amplifier's gain in steps until its output is in approximately the correct range. Then, an output sense amplifier adjusts the output-stage voltage to precisely 1V rms.

The 6900 incorporates a 1-kHz reference source that specs less than 0.003% distortion. This source can provide a stimulus for a system under test or for unit self test.

—Franklin G Fink

Krohn-Hite Corp, Avon Industrial Park, Avon, MA 02322. Phone (617) 580-1660.

Circle No 401



Automatic frequency nulling and level setting allow Model 6900 to make fast, error-free distortion or ac-voltage measurements over 5 Hz to 1 MHz.

Benchtop linear system tests mixed-technology ICs

Advanced hardware resources, a flexible operating system and a dedicated RS-232 link for direct accessibility to SCAN (the manufacturer's Semiconductor Component Analysis Network) combine to make the 1731M a powerful tool for component inspection and analysis. Using an Am9511 hardware math processor to increase throughput, it can test a comprehensive range of linear and mixed-technology chips: SCAN enhances test capability and productivity by providing off-line



programming, program archiving, up- and downloading, data logging and yield analysis.

To achieve its high throughput, the 1731M employs an architecture based on the tandem operation of two μ Ps—a Z80A that works with the math processor to control test sequencing and calculations, and a 6502 that handles a magnetic tape drive. A 5-in. CRT display and 36 custom function keys simplify program entry and user interfacing.

The standard system also includes

A powerful tool for component inspection and analysis, the 1731M benchtop IC tester combines advanced hardware resources, a flexible operating system and a dedicated RS-232 link to SCAN — Semiconductor Component Analysis Network.

Technology Update: New Products

a program library covering more than 800 devices, plus a service-diagnostic kit containing an operational-verification package, an accuracy-verification package and a diagnostic tape to isolate board faults and check other components. Options include a 9-in. CRT and a bar-code reader.

The 1731M mainframe generates the general-purpose forcing, measuring and sequencing functions common to all device testing. Three

plug-in modules—an op-amp family board, ADC/DAC family board and universal family board—house interface circuitry unique to the specific devices tested.

Configured with the op-amp family board, the system costs \$35,000.—**Franklin G Fink**

GenRad Inc, 170 Tracer Lane, Waltham, MA 02154. Phone (617) 890-4900.

Circle No 402

the host computer. Either way, EAROM stores the selected parameters until you choose to change them. An 8086 μ P handles all interface functions.

The unit's graphics engine satisfies all pictorial needs, displaying 16 colors from a choice of 4096 in 640×480 pixels on a 19-in. display. Memory stores the picture as a 4096×4096-pixel display; thus, you can zoom in (continuous scale) on particular features without losing definition or information.

Other features include complete 2-dimensional graphics transformations such as picture rotation, translate and clip. Combined with the manufacturer's circuit-design software, these functions allow you to concentrate on the design instead of the drawing.

A display-list architecture permits manipulation of graphics with minimal host intervention. And the terminal is totally compatible with the software developed for the supplier's more expensive Whizzard 6000 and 7000 Series systems. In fact, the 1650's firmware implements many of the larger terminals' functions, putting many mainframe functions in the terminal and improving system response time.

The terminal furnishes a variety of I/O options for data transfers. It comes with an 8085- μ P-based detachable keyboard that provides programmable function keys and a 10-key accounting pad in addition to the standard typewriter-style keypad. Options include a joystick, data tablet and printer (connected via a Centronics-compatible interface). You can connect camera systems to the video output.

To ensure reliability, the unit runs a complete set of diagnostics. If problems develop, a built-in line analyzer displays the graphics commands. Delivery, 90 days ARO.—**Ed Teja**

Megatek Corp, 3985 Sorrento Valley Blvd, San Diego, CA 92121. Phone (619) 455-5590.

Circle No 403

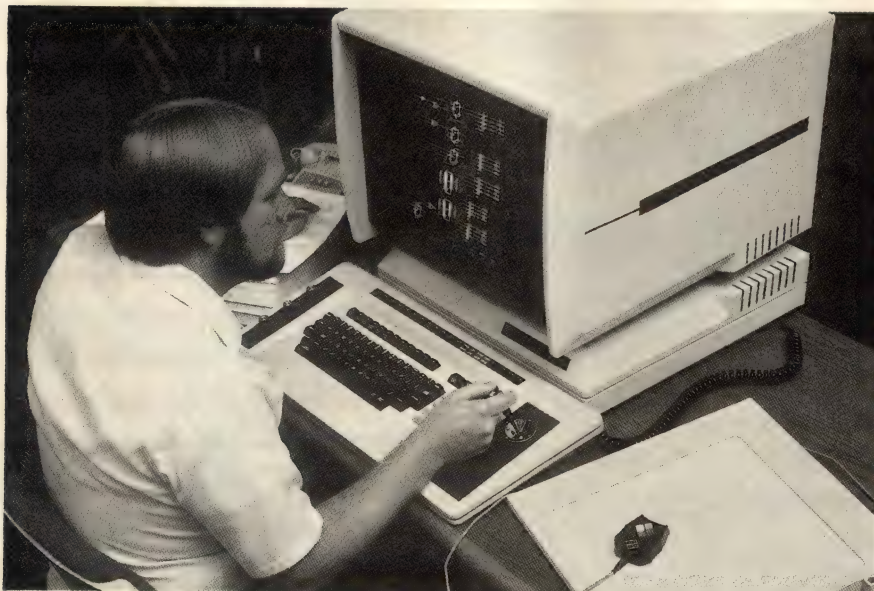
Color engineering terminal puts performance on desktop

Combining designed-to-cost raster displays with a proprietary state machine that handles vector generation, the \$16,000 Whizzard 1650 graphics terminal brings higher productivity, in the form of desktop CAE, within the reach of more designers than ever before.

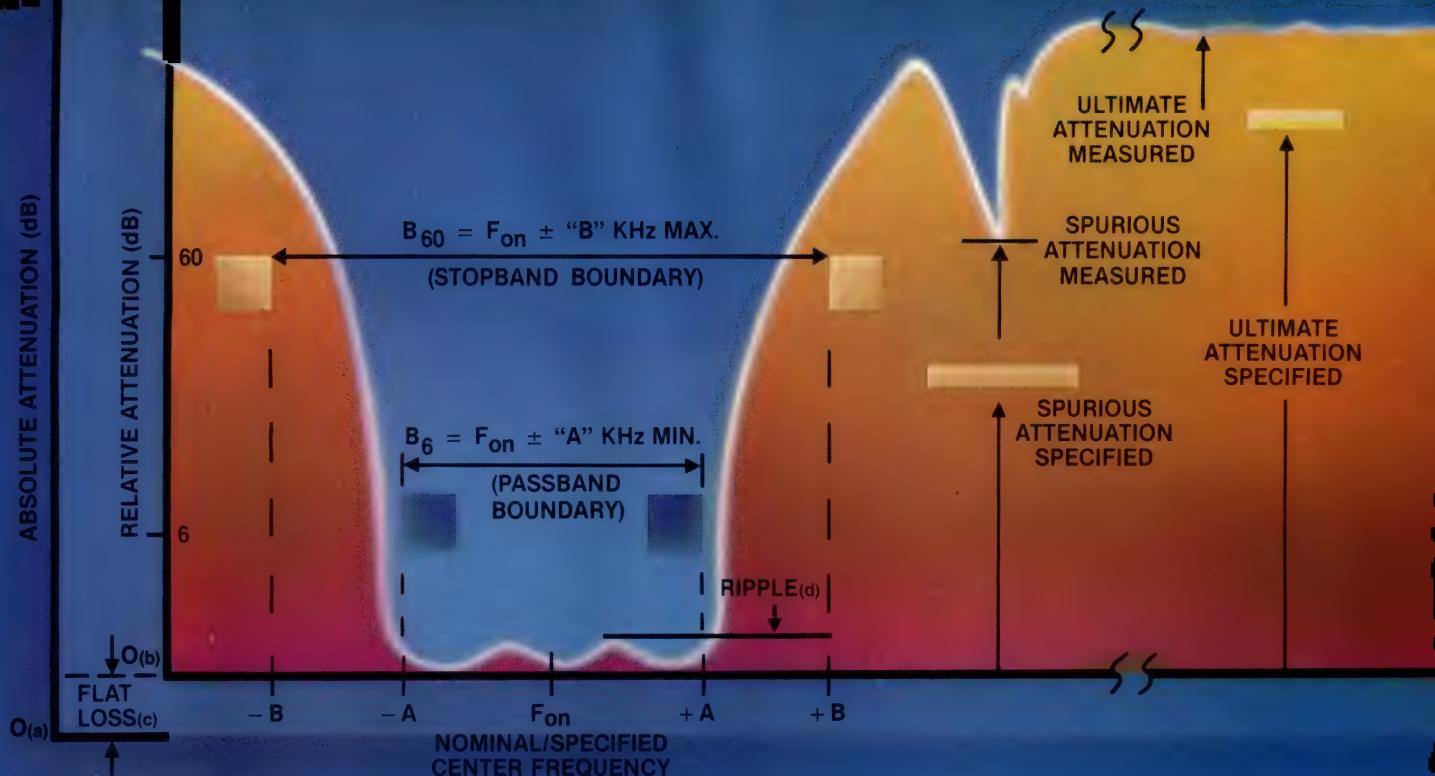
The terminal operates at speeds to 260 nsec/pixel and does the work of both dedicated CAE and standard units. With DEC VT-100/52 compatibility, it accommodates develop-

ment and documentation as well as design engineering; true overlaying lets you simultaneously display text and graphics.

Installation is simple; to configure the system, you merely fill out setup menus with English words that specify the system's complete interface, terminal and graphics characteristics—such as choice of background colors and the screen format. You can also choose to download these parameters from



Operating to 200 nsec/pixel, the \$16,000 Whizzard 1650 displays 16 colors on a 19-in. CRT. Setup menus facilitate system configuration.



- (a) ABSOLUTE ATTENUATION REFERENCE: SIGNAL LEVEL WITH SOURCE MATCHED TO LOAD.
 (b) RELATIVE ATTENUATION REFERENCE: MINIMUM VALUE OF LOSS IN PASSBAND OR PEAK OF TRANSMISSION
 (c) FLAT LOSS: POWER OUT AT PEAK OF TRANSMISSION DIVIDED BY POWER AVAILABLE
 (d) MEASURED FROM PEAK TO VALLEY

A designer's guide to monolithic crystal filters.

Description. Monolithic crystal filters are today's choice for crystal filter applications — used everywhere from mobile radios to medical monitors to satellite communications equipment.

Their unique construction replaces many of the components and interconnections found in discrete filters, resulting in increased reliability, smaller packages and significantly lower costs.

In their simplest form, monolithic crystal filters consist of two, thin-film electrode pairs deposited on the faces of a quartz wafer to form input/output resonators.

Acoustical coupling between the electrode pairs creates a two-pole bandpass filter response. These "two-pole" filters are housed in single miniature (Type "F") or ultraminiature (Type "A") holders.

Four to ten-pole filters are available in miniature/ultraminiature, upright and flatpack designs, as well as in tandem sets — which are particularly suited for high-volume production applications.

Tandem monolithic construction connects, in cascade, two-pole monolithic filter sections using modern network theory. This combines the simplicity and size advantages of monolithic filters with added mode suppression and ultimate attenuation.

How to specify. To ensure getting the right filter to meet your needs, make sure to specify the nominal center frequency (F_{on}), bandwidth and attenuation (both passband and stopband), package specs and any special requirements.

The above illustration shows various monolithic crystal filter response parameters. Note the advantage of using single-sided boundaries for specifying bandwidths.

Who to specify. Stick with the leader. Piezo Technology is the largest U.S. supplier of standard and custom monolithic crystal filters.

Choose from over 100 standard models from 10.7 to 180 MHz, in two to ten-pole configurations. Or take advantage of our unlimited custom capabilities.

A designer's guide, free. Send for our PTI monolithic filter specification form. This handy, easy-to-complete checklist makes sure you don't miss a thing when specifying either standard or custom filters.

For more information and a copy of the PTI specification form, contact your local PTI representative. Or write to the address below.



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CIRCLE NO 55

Technology Update

Monolithic V/F/V converters improve linearity fivefold

Thorough circuit design based on a detailed error budget of internal circuit delays allows Models VFC62 and VFC320 V/F/V converters to greatly improve on the specs of competing products. For example, the devices' linearity is at least five times better than that of any other available monolithic converter.

Top-of-the-line Models VFC62CG (totem-pole output) and VFC320CG (open-collector output)—priced at \$15.45 and \$15 (100), respectively—spec $\pm 0.002\%$ max nonlinearity over 0.01 Hz to 10 kHz. This figure contrasts strikingly with those of other best-grade models: $\pm 0.01\%$ for Raytheon's 4153, Teledyne Semiconductors's 9401CN and the manufacturer's own pin-compatible VFC32; $\pm 0.14\%$ for National Semiconductor's LM131 (*Ed Note: This is the stand-alone spec—with two external op amps, the LM131 specs $\pm 0.01\%$; and $\pm 0.07\%$ for Analog Devices's AD537K.*

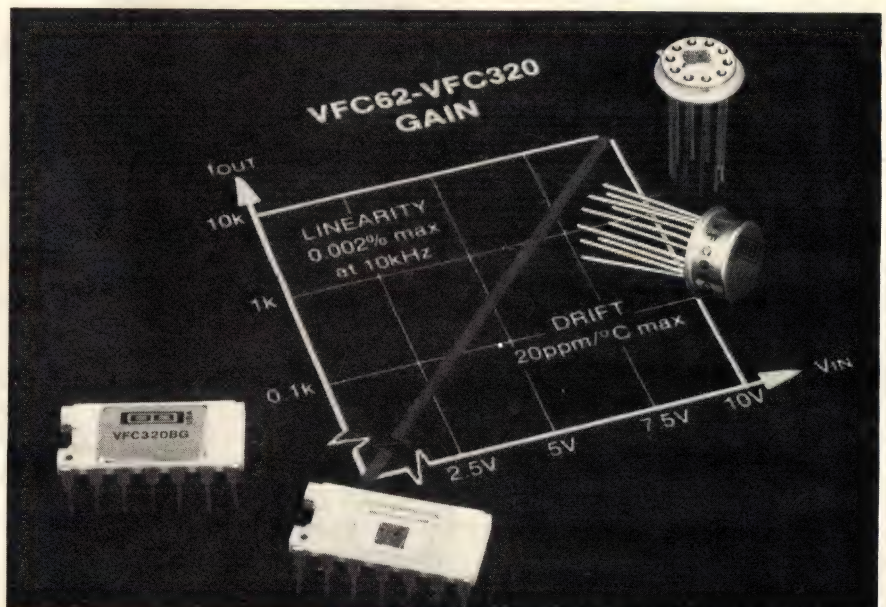
Even the commercial Models VFC62BM and VFC320BM—priced at \$9.20 and \$8.75 (100), respectively—offer advantages. They're specified over -25 to $+85^\circ\text{C}$ and feature $\pm 0.005\%$ max nonlinearity over 0.01 Hz to 10 kHz, making their linearity performance at least twice as good as that of their competitors.

Other 320/62 specs are also impressive. Gain accuracy, gain drift and initial offset equal $\pm 5\%$, ± 20 ppm/ $^\circ\text{C}$ and 15 ppm of FSR, respectively. Operating frequency is 1 MHz max.

Available in a TO-100 (BM/CM/SM) package and 14-pin ceramic DIP (BG/CG), the converters feature DTL, TTL and CMOS output compatibility. They operate from $\pm 15\text{V}$ supplies, with $\pm 6.7\text{-mA}$ max quiescent current.—**Bill Travis**

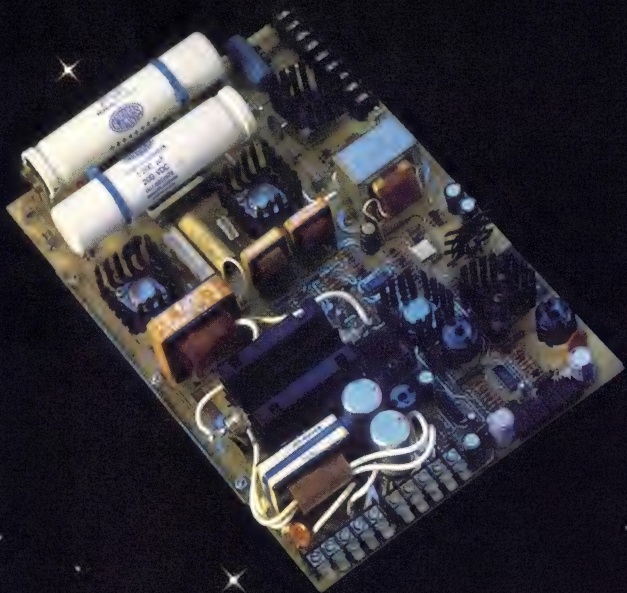
Burr-Brown Research Corp, Box 11400, Tucson, AZ 85734. Phone (602) 746-1111.

Circle No 404



Featuring tight linearity, accuracy and offset specs, the VFC62 and VFC320 monolithic V/F/V converters allow you to transmit and receive data with a 6-decade dynamic range. Inherently monotonic, they provide inexpensive, high-resolution A/D and D/A conversion.

NCR — Used around the world



Complex switching technology demands advanced design and expertise to comply with safety and EMI standards. NCR is recognized as one of the top manufacturers in meeting or exceeding all these standards. Because we are power system specialists, we can track and respond to any changes, thereby keeping our products as the state-of-the-art.

NCR products fill your OEM needs for 50-1200 power systems employing efficient, high-frequency concepts that meet or exceed all international safety and EMI requirements for data processing and peripheral equipment. NCR's standard semi-custom or custom switching power systems pack more power per unit volume and more power per unit weight density than most other systems.

NCR has the manufacturing capability to supply large orders quickly. This shortens your procurement cycle and provides you with proven performance and reliability.

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CIRCLE NO 56

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MORE TELEMETRY DATA ANALYSIS POWER THAN YOU'VE EVER HAD BEFORE!

Telemetry Data Processor

The ADS 100 combines the functional elements of an advanced telemetry demultiplexer with a special purpose data processor to provide a realtime telemetry processing system which specifically addresses the requirements common to most data reduction profiles.

Adaptive System Architecture

A distributive processing architecture achieves high throughput rates by apportioning the data analysis and distribution functions. Various processing modules can be programmed to selectively acquire, process, and distribute data.

Preprocessing Capability

The benefits of the ADS 100 are twofold. The instrument can serve as a small scale, stand-alone telemetry data analysis system, or alternatively, as the real-time preprocessing component for a general purpose computer system.

Expandability—Just Add a Card!

The ADS 100 is expandable in two dimensions: increased capability to process data within a single PCM data stream; and handling of multiple data streams. This is accomplished by the addition of either or both Expansion and Slave Chassis. The Slave Chassis is used when multiple PCM data streams are required. The Expansion Chassis serves to functionally extend the basic

system capability to accept additional processing or I/O modules. Just add a card!

Complete Peripheral Support

System options completely support the acquisition, conversion and formatting of data for peripheral hardware to relieve the host of real-time distribution and control responsibilities. These capabilities include:

- Analog and Digital Output Ports for Strip Charts and Event Monitors
- IEEE-488, ASCII, Line Printer, and Parallel Programming I/O Ports
- IRIG Time Code Generation and Decoding
- Tape Search/Control
- Digital Tape Data Formatting
- Buffered DMA Computer Port

DISPLAY SIMULATOR			
10:07:28			
STIMULATOR SOURCE:	STREAM NUMBER 1	INTERNAL	
FUNCTION GENERATOR:	AMPLITUDE	CYCLES	
NUMBER 1: NAME PUMP	0.00V	1	
NUMBER 2: SINE	1.00V	1	
NUMBER 3: TRIANGLE	0.00V	32	
NUMBER 4: SQUARE	0.00V	32	
COMMON WORD VALUE: 0111001100000101			
PARAMETER NAME:	SPECIAL WORD VALUES:		
AIR SPEED	FUNCTION GENERATOR 2		
AIR TEMP	FUNCTION GENERATOR 3		
FUEL FLOW	0111100000000110		
OIL PRESSURE	0111100000000110		
ALTITUDE	FUNCTION GENERATOR 4		
OIL TEMP	EXTERNAL ANALOG		

CHASSIS PARAMETER			
10:07:17			
NAME:	OIL PRESSURE	YND 000C	
DEST CODE:	0075721	00V 00	
DATA TYPE:	PRIME	REMARK	
SOURCE:	LOCATION	INCREMENT	PARITY
WORD:	0000	0000	00
FRAME:	000	001	
EU CONVERSION: 0.234x+27			
FORMAT:	PLANT	EE 0	
UNITS:	000000	000000	
ALARM:	LOWER 00100	UPPER 0000	
CONDITION:	LOWER 00100	UPPER 0000	
INITIAL:	000	FUEL LOW	
MESSAGE:	000	FUEL LOW	
RESPONSE:	0000	0000	

Loral gives you the ADS 100—The expandable system for telemetry data analysis of more data, with less software and at a lower cost!

ADS 100

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Leadtime Index

PASSIVE COMPONENTS

PRODUCT	LEADTIME IN WEEKS			PRODUCT	LEADTIME IN WEEKS		
	Min.	Max.	Trend		Min.	Max.	Trend
CAPACITORS				PRINTED CIRCUITS			
Ceramic, disc	4	12	=	Single-sided	6	8	=
Ceramic, monolithic	4	12	=	RELAYS AND TIMERS			
Electrolytic, aluminum	1	14	↗	Crystal can	6	10	=
Electrolytic, tantalum	6	8	↗	General purpose	5	12	↗
Film	1	12	↘	Miniature (TO-5, square)	4	10	=
Mica	6	14	=	Reed, dry	4	8	↗
Paper	1	9	↘	Reed, mercury-wetted	4	12	=
Trimming	1	10	=	Solid state	4	8	=
CRYSTALS, FILTERS AND NETWORKS				Telephone	1	8	=
Filter, active	7	10	=	Time delay and timer	2	6	=
Filter, EMI	10	16	=	RESISTORS, FIXED			
Filter, lumped-constant	10	19	=	Carbon film	4	8	↗
Filter, quartz (monolithic)	2	20	=	Composition	3	5	=
Freq. determining crystal	2	10	=	Metal film	3	11	=
ENCLOSURES				Network	3	9	=
Custom	6	10	=	Wirewound	2	10	=
Modified standard	10	14	=	RESISTORS, VARIABLE			
Standard	8	12	=	Pot, nonprecision WW	2	16	=
FANS AND BLOWERS				Pot, precision WW	2	14	=
FRACTIONAL HP MOTORS				Pot, nonprecision comp.	3	8	=
INDUCTIVE COMPONENTS				Pot, precision comp.	9	12	↗
Coil	9	18	=	Trimmer, WW	2	12	↗
Solenoid	2	6	=	Trimmer, comp.	3	10	=
Transformer, power	7	10	=	SWITCHES AND KEYBOARDS			
Transformer, other	6	12	=	Circuit breaker	6	16	=
INTERCONNECTION COMPONENTS				Dual in-line	4	11	=
Back panel	6	12	=	Keyboard and keyswitch	8	10	↘
Flat cable	2	10	↘	Lighted pushbutton	5	12	↗
Multipin circular high-density	4	18	=	Pushbutton	5	12	↗
Multipin circular standard	4	16	↘	Rotary	2	12	↘
Packaging panel	3	10	=	Snap action	4	8	=
PC, one-piece	2	10	↘	Thumbwheel	8	10	=
PC, two-piece	2	9	↘	Toggle	5	6	↗
Rack and panel	7	12	↘	TRANSDUCERS			
RF coaxial	4	15	=	Pressure	6	10	=
Socket	2	10	↘	Temperature	5	12	=
PRINTED CIRCUITS				WIRE AND CABLE			
Double-sided	4	12	=	Coaxial cable	8	14	=
Flexible	1	8	=	Flat and ribbon cable	4	8	=
Laminates	4	10	=	Hookup wire	2	5	=
Multilayer	6	16	↘	Multiconductor cable	4	12	=

Leadtimes are based on recent figures supplied to *Electronic Business* magazine by a composite group of major manufacturers and OEMs. They represent the typical times necessary to allocate manufacturing capacity to build and ship a medium-sized order for a moderately popular item. Trends represent changes expected for next month.

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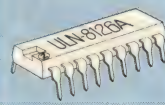
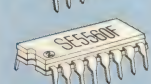
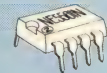
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		ULS-8126R	SG1526J	-55°C to +125°C	
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		ULS-8160R	SE5560F	-55°C to +125°C	
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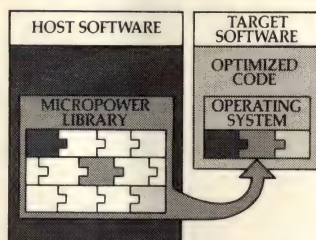
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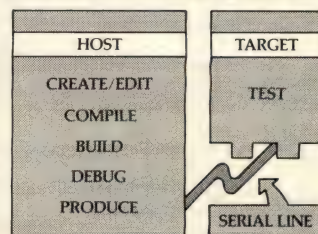
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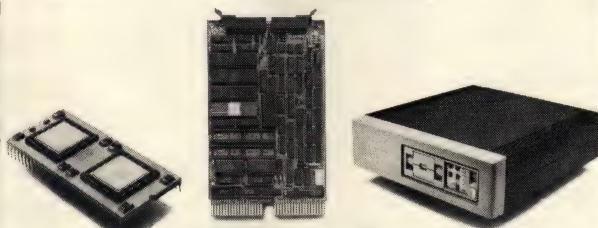
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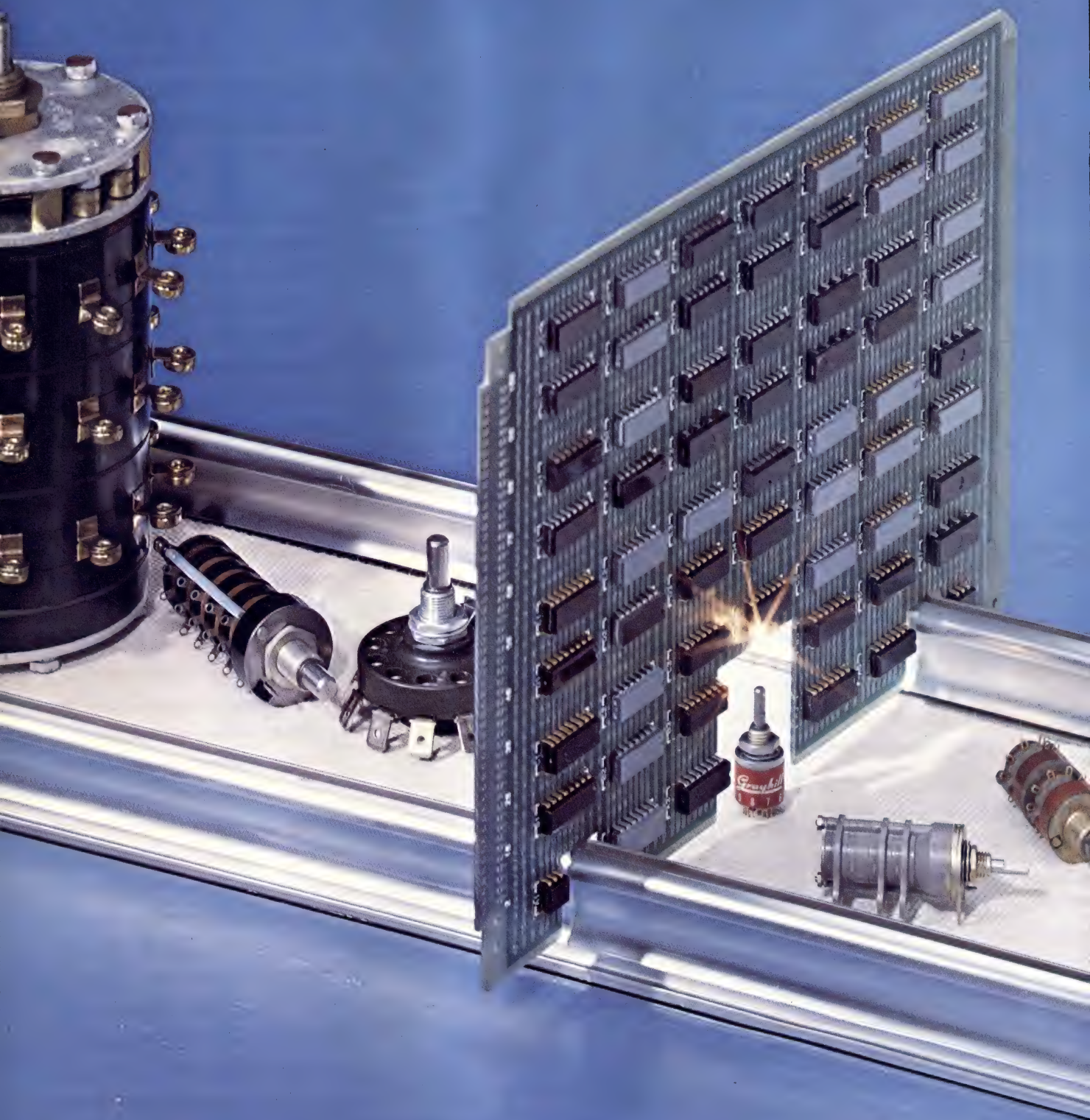
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More than a micro.

digital



High-density pc-board designs have spurred development of smaller rotary switches that meet the needs of μP -based systems.
(Photo by Beach & Barnes, courtesy Grayhill Inc)

ROTARY SWITCHES

*Maturity needn't be equivalent to stagnation.
Although rotary switches have been around for years,
the latest introductions have a new look.*

Tom Ormond, Senior Editor

Discrete rotary switches might be a mature technology, but they still provide the best way of controlling multicircuit functions. And although mature, they've adapted to changing design needs: In addition to the familiar bulky open-frame designs, a new generation of rotary switches, developed in response to the μ P's needs, has appeared. These new units are much smaller but sacrifice nothing in performance or control capability: Single- or double-deck switches in packages measuring less than 1 in. in diameter can replace older 2-in.-diameter units with as many as 12 decks.

In addition to reduced size, the newest rotary switches provide simpler design and construction. As a result, they're more compatible with automated manufacturing techniques and therefore less labor intensive than their predecessors. Many come in enclosed or sealed versions that can mount on pc boards and be wave-soldered along with other components, thereby eliminating costly hand-soldering operations. Furthermore, coded-output rotaries are now available for use in logic-level applications, where they convert decimal inputs into computer codes.

The μ P-fostered surge in rotary-switch product introductions has also created some less obvious changes in the rotary-switch field. Logic-level switching, for example, has altered contact-resistance requirements. μ P-compatible switches need only detect logic-level changes; the logic circuitry can distinguish between ONE and ZERO so long as it can sense the difference between an open circuit and a closed one. Therefore, a switch's closed contact resistance need no

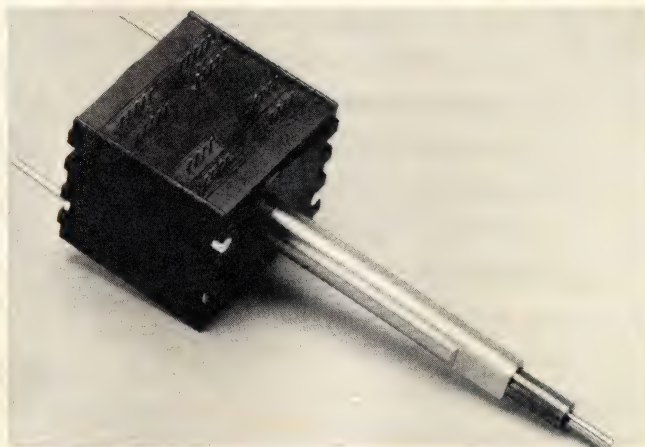


Despite extensive listings, rotaries are still custom devices



For use in set-and-forget military applications, Minelco's miniature rotary switches accommodate pc-board (SW32) and panel (SW37) mounting. Both feature a choice of shorting or nonshorting contact styles that have gold plating to accommodate dry-circuit switching.

Stringent military requirements are no problem for AMP's Series 3510 switches. Designed for applications in advanced flight-deck navigational systems, the dual- and triple-shafted units employ palladium-silver contacts to ensure their 30,000-cycle lifetime. ▼



Big performance in a small package is a prime feature of Series 910 and 912 switches from Centralab. Measuring less than 0.5 in. in diameter, they offer 10-position capacity, switch 500 mA, spec a 10,000-cycle life and come in sealed or unsealed versions.

longer be in the milliohm range—a feature that adds new options to the list of potential contact materials. Specifically, logic-level switches in noncritical applications can use conductive bonded-polymer contacts. This reduction in the need for precious-metal contacts and contact platings results in less expensive switches.

Circuit miniaturization has also served to reduce voltage and current switching-level requirements, increasing the need for switches capable of handling dry-circuit conditions (extremely low voltages and currents).

Still a custom business

The newer rotary switches are therefore designed to satisfy an entirely different range of applications than



Measuring only 0.3 in. in diameter, Grayhill's Series 75 rotary switches (left) spec 10-position capacity and handle dry-circuit applications.

their predecessors. But one factor remains constant: Rotary-switch specification still isn't easy.

Indeed, it really isn't possible to obtain an off-the-shelf rotary switch. Although companies such as Centralab and Grayhill offer a significantly large listing of catalog items, such catalog listings typically only define a family of switches—units with essentially the

same basic dimensions and make/break current ratings. And a family of multideck rotaries can have more than 40,000 possible combinations when you consider all variables: external features (shaft/panel seal, type of termination and MIL qualification, for example), angle of throw, number of decks, poles per deck and shorting or nonshorting contacts, to name a few.

This diversity can lead to trouble: Unless you know how to combine variables to obtain the functions and performance you need, you can easily wind up with a spec that calls for a switch with higher performance than necessary. The switch could even be entirely wrong for your application.

For example, it's important not to abuse safety

factors. If your application needs a switch with a 10,000-cycle lifetime, you might specify a lifetime 10 to 30% greater as a safety margin, but you shouldn't ask for 25,000 cycles as a performance cushion. The reason? Silver-plated brass contacts are sufficient for a 10,000-cycle lifetime, but a 25,000-cycle switch requires silver-overlay contacts costing five times as much.

Similarly, specifying a 2A switch for a 100-mA circuit won't provide the necessary reliability tolerance. Instead, it alters contact force and other requirements to the point where the indicated switch could cost several times more than the unit you really need. Worst of all, the 2A switch might not even work at the lower current level: Its contact material might not be appropriate for

Designing low cost into rotary switches

At Wescon/82, Grayhill Inc introduced the Series 55 and 56 rotary switches—low-cost versions of its 10-yr-old military-quality Series 50 and 51 units. The **figure** illustrates some of the designed-to-cost innovations in this family that allow it to remain competitive with new designs.

Grayhill designers first replaced the 50/51 Series's brass screw-machined housing with a zinc die-cast housing that requires no secondary manufacturing opera-

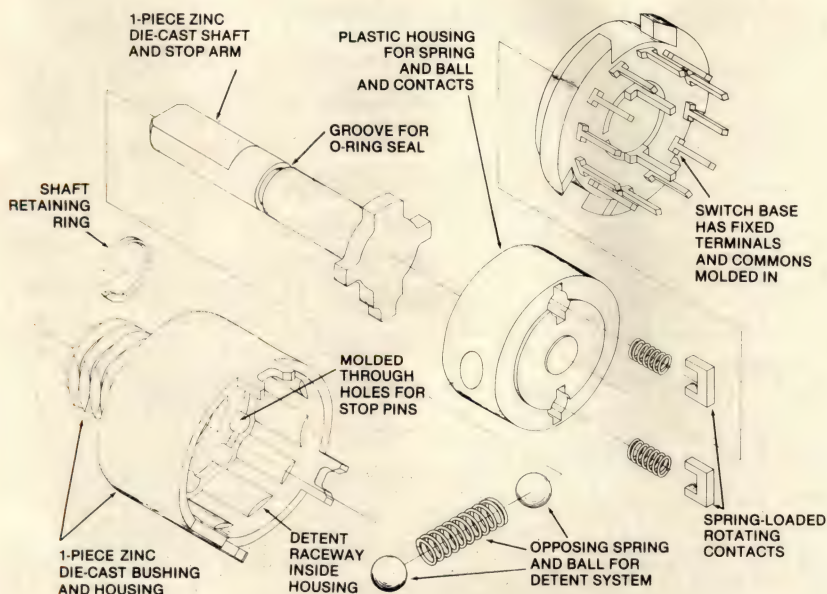
tions. The die casting includes molded-in holes for both the fixed and adjustable stop pins and provisions for mounting shaft or panel seals. The raceway for the opposing spring-and-ball detent system, previously part of the plastic piece that included the switch terminals, is also molded into the housing—providing a decided manufacturing cost advantage.

The more expensive 50/51 switches employ an assembly that includes the stop arm, stainless-

steel shaft and molded-on detent rotor. The zinc die-cast 1-piece shaft and stop-arm design in the 55/56 units provides additional savings by reducing parts count and eliminating some assembly time. The rotor detent is molded as a separate piece; the newer design eliminates the need to feed the shaft and stop-arm assembly into the mold at the press and thus saves labor costs.

The low-cost design retains a spring-loaded contact that connects the switch common and the selected position terminals. But it eliminates some individual parts that were required in the more expensive 50/51 rotaries. In addition, the switch base that holds the terminals and common rings is simpler to manufacture and easier to clean. The plastic material's thermal properties prevent movement of the terminals when they are subjected to heat from wave or manual soldering.

The cost savings provided by these changes are reflected in the units' final prices: Standard-grade 1-pole 50/51 Series devices with two through 10 positions, 36° throw angle and nonshorting contacts cost \$9.50, whereas identical 55/56 units run \$7.50.



Avoid overspec'ing safety factors; you could invite erratic performance

handling milliamp currents. The bottom line: You are not designing-in a safety factor when you invite erratic switch operation.

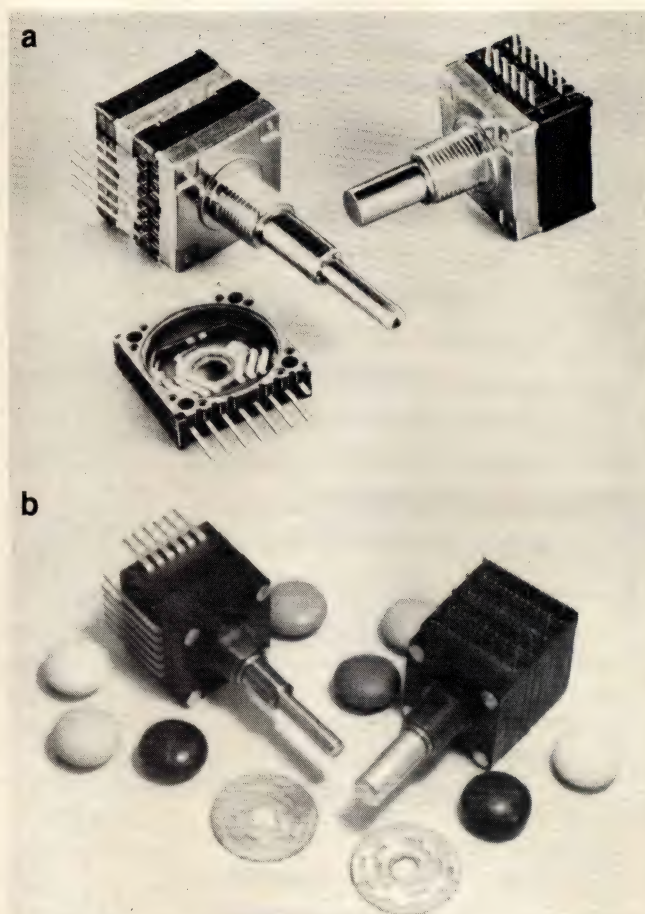
Take a close look at spec sheets

Your chances of properly specifying rotary switches increase significantly when you understand the units' spec sheets. Manufacturers list specific make/break currents for a source of voltage and load type, along with lifetimes (expressed in operating cycles) to meet various failure criteria. And some manufacturers simplify this data presentation through a graph that displays make/break current versus lifetime; this approach gives you a quick indication of whether make/break currents meet your life requirements.

The important thing to remember about catalog or data sheets, though, is that their headlines basically provide first-sort information—an indication of current rating and switch size. You must then take the time to read the small print and determine whether a unit can indeed meet the specifics of your application. Variables to consider include the switch's contact style, whether it has enough poles and positions for your needs, whether its lifetime specs are adequate and whether its contact material suits your application.

In most cases, you'll have minimal problems because most rotaries are conservatively rated. However, some designers have chosen the wrong switch because they were influenced solely by size considerations or because the current rating seemed correct for the application.

Don't assume that potential problems are restricted to higher switching levels, either. The newest minia-



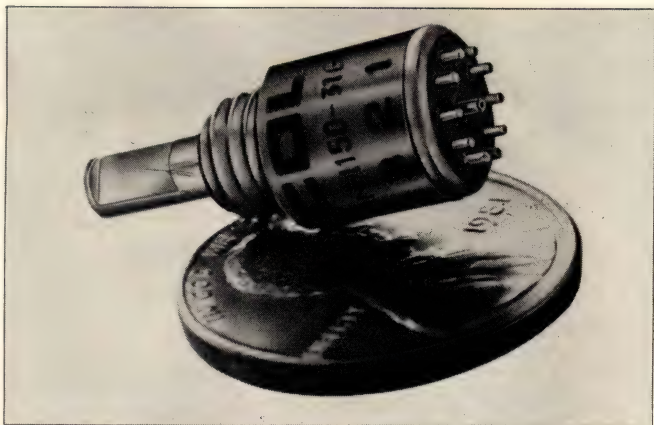
Direct logic-level interfacing is simplified with these encoded-output rotary switches from Oak Switch (a) and Standard Grigsby (b). Both measure less than 1 in. square and come with BCD, hexadecimal and Gray output codes.

REPRESENTATIVE MINIATURE ROTARY SWITCHES

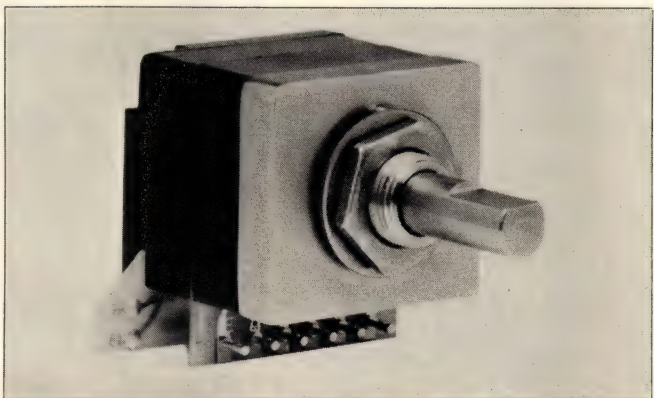
COMPANY*	MODEL/SERIES	DIAMETER (IN.)	POLES	POSITIONS	STOPS ¹	CONTACT STYLE ²	CONTACT RATINGS (SWITCHING)	LIFETIME (CYCLES)
ALCO	MRJ	0.5	1, 2, 3, 4	12, 6, 4, 3	F, A	N 4	0.4 VA/20V DC	10,000
C & K	A	0.87	1, 2, 3, 4	12, 6, 4, 3	A	N	350 mA/115V AC OR DC 150 mA/250V AC OR DC	15,000
CENTRALAB	910, 912	0.475	1	3, 4, 5, 6, 8, 10	F	N	0.5A/12V DC 0.3A/24V DC	10,000
COLE	1150	0.32	1	2 TO 10	—	N, S	2A	30,000
DIGITRAN	56000	0.6875	1	8	F	N	125 mA/28V DC	25,000
GRAYHILL	75	0.3	1, 2	10, 5	F	N	200 mA	15,000
ITW SWITCHES	MR	0.32	1	2 TO 10	F	N	25 mA/125V DC	—
MINELCO	SW32, SW37	0.35	1	2 TO 6	F	N, S	250 mA/28V DC	—
NKK	MRA	0.63	1, 2, 4	12, 6, 3	A	—	250 mA/125V AC	10,000
OAK	500	0.5	1, 2	4, 6, 8, 10, 12	F, A	N, S	2A/28V DC 1A/110V AC	25,000
STACKPOLE	80	SEE TEXT	1, 2, 3, 4	12, 6, 4, 3	F, A	N, S	500 mA/28V DC 100 mA/110V AC	—

NOTES

1. STOPS—F DENOTES FIXED, A DENOTES ADJUSTABLE
2. STYLES—N DENOTES NONSHORTING, S DENOTES SHORTING
3. TERMINATION—PC DENOTES PRINTED CIRCUIT, SL DENOTES SOLDER LUG
4. SEE MANUFACTURERS LIST FOR COMPLETE COMPANY NAMES AND ADDRESSES



Small but rugged, Cole Instruments's Series 1150 rotaries achieve 10-position capacity in a 0.32-in.-diameter package and meet applicable requirements of MIL-S-3786.



A coded rotary switch with panel seal, Digitran's Series 55000 unit comes with as many as six decks and 12 dial positions. Designed to accommodate severe environmental conditions, it operates over -55 to $+105^{\circ}\text{C}$ and specs 100g min shock resistance.

ture rotary switches are designed primarily for low-level switching: They handle currents of 1A or less. But for dry-circuit currents (typically in the low-milliamp range), gold contacts are almost mandatory for reliable switching. And many manufacturers of miniature rotaries don't provide this feature; Alco, Cole, Grayhill and Minelco are among those that do. True, *any* rotary switch's wiping action helps in dry-circuit applications—even if the unit is not a gold-contact device. But it's best to choose a switch whose contact material is optimum for dry-circuit switching.

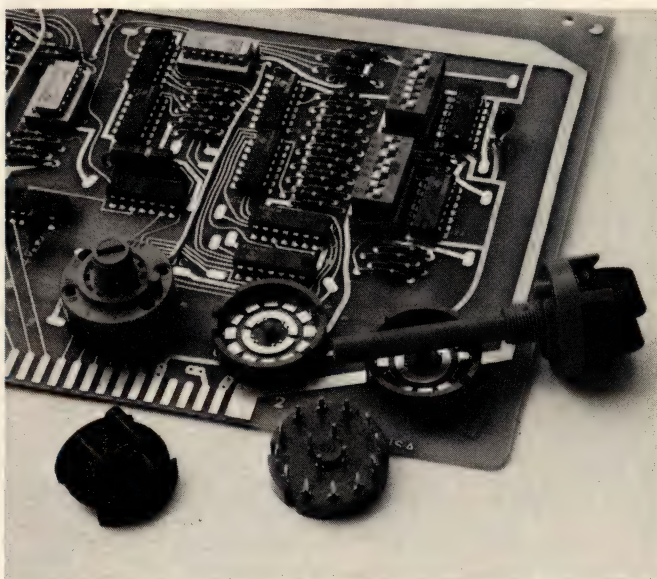
The best way to avoid problems, of course, is to use the switch manufacturer's expertise. With a knowledge of your load requirement and switch functions, the manufacturer can provide all necessary assistance in the selection process.

As the data in the **table** illustrates, today's miniature rotary switches certainly don't lack in performance. Electrical-load ratings are somewhat limited but are more than adequate for the low-level switching applications the units are designed to serve. With the exception of Stackpole's switches, which are $1\frac{3}{16} \times \frac{9}{16}$ -in. rectangular designs with pc pins spaced on 0.1-in. centers extending from the rear, all the units look similar on the outside. On the inside, however, you'll find quite a bit of variation.

For example, some switches are single-pole units, while others have as many as four poles. You'll find a 2:1 variation in maximum switch positions for single-pole units, an 80:1 span in load-current ratings and a 3:1 range in lifetime specs.

Some mechanical differences are also evident. For

TERMINATION*	REPRESENTATIVE PRICE
PC	\$4.80 (100) FOR 1-POLE, 12-POSITION ADJUSTABLE
PC, SL	\$1.86 (100)
PC	\$5.69 (100) FOR 1-POLE, 10 POSITION SERIES 912
PC	—
PC	\$28.10 (100)
PC	\$13.19 (100) FOR 1-POLE, 10-POSITION
PC	\$7.98 (1000) FOR 1-POLE, 10-POSITION
PC, SL	\$13.00 (1000) FOR 1-POLE, 6-POSITION SW32
PC	\$5.12 (1000) FOR 1-POLE, 12-POSITION
PC, SL	\$4.50 (1000) FOR 1-POLE, 10-POSITION
PC	\$2.50 (100) FOR 1-POLE, 12-POSITION



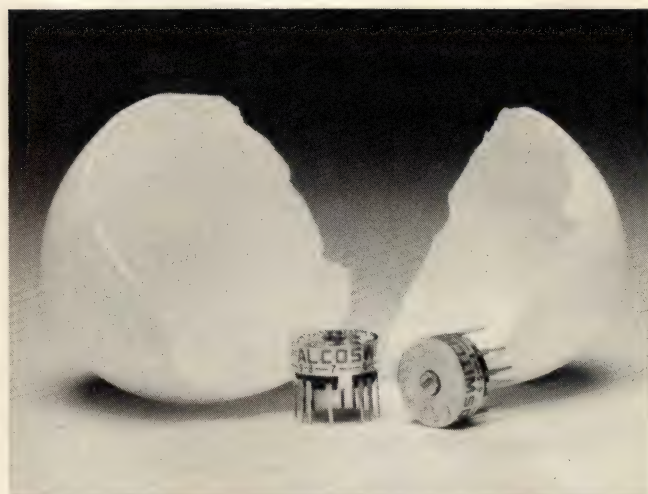
To accommodate wave-soldering and board-cleaning operations, C&K Components employs modular construction in its Series A switches. A disposable cap protects the contacts during soldering and cleaning; at final assembly, you remove the cap and snap the shaft/housing assembly into place.

Choose the contact material that's best for the application

example, some switches come with fixed stops; others have adjustable stops—a feature that increases flexibility and can help reduce inventory costs. With it, you can stock one basic switch type for use in similar applications and then customize it (by changing stop pins or washers) to meet specific needs as they arise.

There's also a difference in contact styles: You can obtain nonshorting and shorting units. With nonshorting contacts, the first connection breaks before the second connection makes; with shorting contacts, the second connection makes before the first connection breaks. Shorting-type contacts minimize arcing problems, and they also eliminate the discontinuities evident with nonshorting units as you switch rotary positions.

The miniature rotaries are all designed for pc-board mounting. Therefore, they come in enclosed packages that are compatible with wave-soldering techniques. With regard to board cleaning, however, there's more



Maximum function control in a minimum amount of space is a feature of Alco Electronic Products's MRJB switches. They furnish 1-, 2-, 3- and 4-pole switching with 12-, 6-, 4- and 3-position capacities, respectively.

Manufacturers of rotary switches

For more information on rotary switches, contact the following manufacturers directly or circle the appropriate numbers on the Information Retrieval Service card.

Airflyte Electronics Co
Box 231
Bayonne, NJ 07002
(201) 436-2230
Circle No 665

Alco Electronic Products Inc
1551 Osgood St
North Andover, MA 01845
(617) 685-4371
Circle No 666

Alps Electric USA
100 N Centre Ave
Rockville Center, NY 11570
(516) 766-3636
Circle No 667

AMP Inc
Eisenhower Blvd
Harrisburg, PA 17105
(717) 564-0100
Circle No 668

Ark-Les Corp
51 Water St
Watertown, MA 02172
(617) 924-2330
Circle No 669

ASM
525 Truck Lane
Smithfield, NC 27577
(919) 934-3104
Circle No 670

Astrosystems Inc
6 Nevada Dr
Lake Success, NY 11042
(516) 328-1600
Circle No 671

Baytron
344 Salem St
Medford, MA 02155
(617) 391-1550
Circle No 672

Bowmar/TIC Inc
850 Lawrence Dr
Newbury Park, CA 91320
(805) 498-2161
Circle No 673

C&K Components Inc
15 Riverside Ave
Newton, MA 02158
(617) 964-6400
Circle No 674

Calvert Electronics Inc
1 Branca Rd
East Rutherford, NJ 07073
(201) 460-8800
Circle No 675

Carlingswitch Inc
505 New Park Ave
West Hartford, CT 06110
(203) 233-5551
Circle No 676

Carson Mfg Co
5453 N Rural St
Indianapolis, IN 46220
(317) 257-3191
Circle No 677

Carter Mfg Corp
237 Sugar Rd
Bolton, MA 01740
(617) 779-5501
Circle No 678

Centralab Inc
Box 858
Ft Dodge, IA 50501
(515) 955-8534
Circle No 679

Cherry Electrical Products Corp
3623 Sunset Ave
Waukegan, IL 60085
(312) 689-7000
Circle No 680

Clarostat Mfg
1 Washington St
Dover, NH 03820
(603) 742-1120
Circle No 681

Cole Instruments Corp
2650 S Croddy Way
Santa Ana, CA 92704
(714) 556-3100
Circle No 682

Cogenal Inc
2 Ram Ridge Rd
Spring Valley, NY 10977
(914) 425-7460
Circle No 683

Crouse-Hinds Co
103 Hawthorn St
Hartford, CT 06101
(203) 249-8471
Circle No 684

CTS Corp
905 Northwest Blvd
Elkhart, IN 46514
(219) 293-7511
Circle No 685

C W Industries
130 James Way
Southampton, PA 18966
(215) 355-7080
Circle No 686

Digitran Co
855 S Arroyo Parkway
Pasadena, CA 91105
(213) 449-3110
Circle No 687

Duncan Electronics Inc
2865 Fairview Rd
Costa Mesa, CA 92626
(714) 545-8261
Circle No 688

EAO Switch Corp
255 Cherry St
Milford, CT 06460
(203) 877-4577
Circle No 689

Eaton Corp/Cutler Hammer Products
4201 N 27th St
Milwaukee, WI 53216
(414) 449-6000
Circle No 690

**Edison Electronics Div
Armtec Industries**
Manchester Municipal Airport
Manchester, NH 03103
(603) 669-0940
Circle No 691

EECO Inc
1601 E Chestnut Ave
Santa Ana, CA 92701
(714) 835-6000
Circle No 692

Electro Switch Corp
180 King Ave
Weymouth, MA 02188
(617) 335-5200
Circle No 693

Essex Controls
1601 Wall St
Ft Wayne, IN 46804
(219) 753-7521
Circle No 694

G C Electronics
400 S Wyman St
Rockford, IL 61101
(815) 968-9661
Circle No 695

Gordon Co
5710 Kenosha St
Richmond, IL 60071
(815) 678-2211
Circle No 696

Grayhill Inc
561 Hillgrove Ave
LaGrange, IL 60525
(312) 354-1040
Circle No 697

**Interswitch/
W J Purdy Co**
770 Airport Blvd
Burlingame, CA 94010
(415) 347-8217
Circle No 698

variation: Not all devices withstand total-immersion cleaning. But units from Alco, Centralab, Cole, Digitran, Grayhill, Oak and NKK are fully sealed.

C&K takes a different and noteworthy approach to board-cleaning compatibility: It provides its plastic A Series rotaries in modular form. The switch bases come with a disposable cap that protects the contacts during pc-board assembly; after wave soldering and cleaning, you remove the cap and snap the switch's shaft/housing assembly into place.

Finally, note that although the devices from Digitran and Stackpole do provide coded-output options, the miniature units described in the **table** are essentially 1-of-n selector switches. Other recent product introductions from Standard Grigsby, Edison, Oak, AMP, Grayhill, Digitran and Centralab, however, are designed primarily for direct logic-level interfacing.

Using a printed-circuit logic disk programmable at the factory to any user-specified truth table, Standard

Grigsby's MM P/Rel switches eliminate the cost and space requirements associated with A/D conversions in switching applications. Measuring just 0.865 in. square, they are available with an optional mechanism that allows you to adjust the number of stop positions down from the 28-position maximum capacity. Terminals are insert molded into the housing, so the units can be wave soldered.

Hexadecimal, BCD and Gray codes are standard, but others are available on special order. Standard contacts are phosphor bronze with silver inlays at the interface with the program disk (gold inlays are also available). Optional gold plating is also available for the glass/epoxy copper-clad program disks, which typically come with silver plating. Contacts come in shorting and nonshorting styles (to 16 positions). Load rating specs at 250 mA/28V dc, and lifetime measures 50,000 cycles.

True pc-board-compatible rotaries, Edison's 12000 Series switches come in 8- (12100), 14- (12200) and

ITT Shadow

8081 Wallace Rd
Eden Prairie, MN 55344
(612) 934-4400
Circle No 699

ITW Switches

6615 W Irving Park Rd
Chicago, IL 60634
(312) 282-4040
Circle No 700
(Combines UID, Licon, Chicago Switch and RCL operations)

Janco Corp

Box 3038
Burbank, CA 91504
(213) 846-1800
Circle No 701

Kel-Am Inc

Box 313
Eldon, MO 65026
(314) 392-7174
Circle No 702

Lake Shore Electric Corp

205 Willis St
Bedford, OH 44146
(216) 232-0200
Circle No 703

Lamb Industries Inc

Box 25110
Portland, OR 97225
(503) 297-8878
Circle No 704

Ledex Inc

Box 427
Vandalia, OH 45377
(513) 898-3621
Circle No 705

Matrix Systems

5177 N Douglass Fir Rd
Calabasas, CA 91302
(213) 992-6776
Circle No 706

Maurey Instruments

4555 W 60th St
Chicago, IL 60629
(312) 581-4555
Circle No 707

Methode Electronics Inc

7447 W Wilson Ave
Chicago, IL 60656
(312) 867-9600
Circle No 708

Microlab/FXR

10 Microlab Rd
Livingston, NJ 07039
(201) 992-7700
Circle No 709

Minelco Div/Talley Industries

135 S Main St
Thomaston, CT 06787
(203) 283-8261
Circle No 710

Mouser Electronics

11433 Woodside Ave
Lakeside, CA 92040
(714) 449-2222
Circle No 711

Multi-Tech Industries

Hwy 79
Marlboro, NJ 07746
(201) 431-0550
Circle No 712

Mura Corp

177 Cantiague Rock Rd
Westbury, NY 11590
(516) 935-3640
Circle No 713

NKK Switches of America Inc

14415 N Scottsdale Rd
Scottsdale, AZ 85260
(602) 991-0942
Circle No 714

New England Instruments

14 Kendall Lane
Natick, MA 01760
(617) 875-9711
Circle No 715

Oak Switch Systems

100 S Main St
Crystal Lake, IL 60014
(815) 459-5000
Circle No 716

Ohmite Mfg Co

3601 W Howard St
Skokie, IL 60076
(312) 675-2600
Circle No 717

Omega Engineering

Box 4047
Stamford, CT 06907
(202) 322-1666
Circle No 718

Otto Engineering

2 E Main St
Carpentersville, IL 60110
(312) 428-7171
Circle No 719

Peerless Radio

19 Wilbur St
Lynbrook, NY 11563
(516) 593-2121
Circle No 720

Poly Scientific

1213 N Main St
Blacksburg, VA 24060
(703) 552-3014
Circle No 721

Ross Engineering

559 Westchester Dr
Campbell, CA 95008
(408) 377-4621
Circle No 722

Shalco Inc

Box 1089
Smithfield, NC 27577
(919) 934-3135
Circle No 723

Spectrol Electronics

17070 E Gale Ave
City of Industry, CA 91749
(213) 965-6565
Circle No 724

Stackpole Components

Box M
Farmville, VA 23901
(804) 392-4111
Circle No 725

Standard Grigsby Inc

920 Rathbone Ave
Aurora, IL 60507
(312) 844-4300
Circle No 726

Stanford Applied Engineering

3520 De La Cruz Blvd
Santa Clara, CA 95050
(408) 988-0700
Circle No 727

Switchcraft Inc

5555 N Elston Ave
Chicago, IL 60630
(312) 792-2700
Circle No 728

TEC Inc

2727 N Fairview Ave
Tucson, AZ 85705
(602) 792-2230
Circle No 729

Telonic/Berkeley

2825 Laguna Canyon Rd
Laguna Beach, CA 92652
(714) 494-9401
Circle No 730

Unimax Switch Corp

Ives Rd
Wallingford, CT 06492
(203) 269-8701
Circle No 731

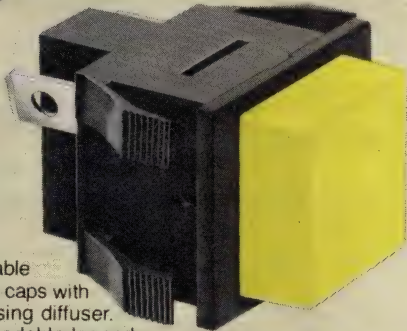
Waldman Corp

3 Eastman Rd
Parsippany, NJ 07054
(201) 887-8900
Circle No 732

Waldon Electronics

4327 W 69th St
Chicago, IL 60629
(312) 585-1212
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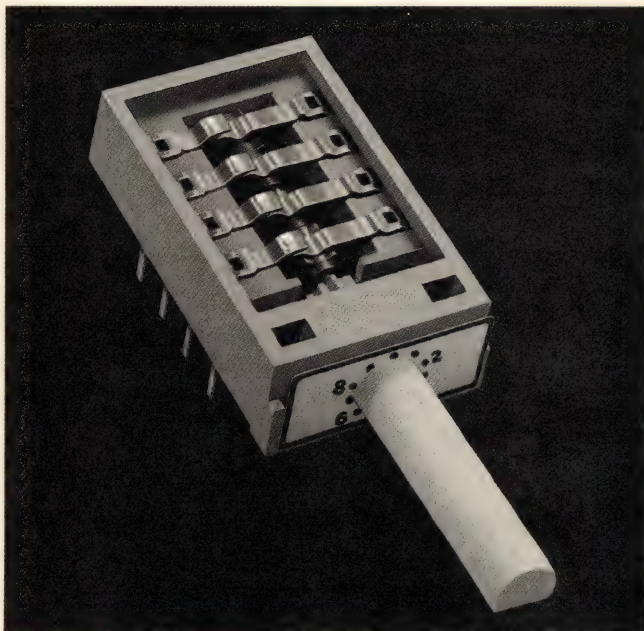
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CIRCLE NO 60

**Totally sealed rotary switches
accommodate wave soldering**



To achieve maximum packing density, Edison houses its 12000 Series rotaries in DIPs. The devices feature coded outputs and a 10,000-cycle lifetime and handle 125-mA loads.

16-pin (12300) DIPs. BCD, BCO (binary-coded octal) and complements are standard, but custom codes are available. Minimum lifetime specs at 10,000 cycles. Mounted height measures 0.232 in., and the contacts (beryllium copper or CA725 with plated or clad gold over nickel) spec a 125-mA/115V ac or dc load rating.

Wave solderability, sealing against solvent/particulate contamination and 50,000-cycle lifetime are some of the features offered by Oak's Series 850 programmable rotary switches. Hexadecimal, BCD and Gray codes are standard, others optional. Measuring 0.85 in. square, these switches come with as many as 28 positions—four sections with seven outputs plus common per section.

You can mount the Oak switches parallel or perpendicular to a pc board. A single section measures only 0.4 in. high, and each additional section adds only 0.2 in. to the switch's total height (or depth). Contacts (gold or silver alloy on copper, as required by the application) have a resistive-load ambient-temperature rating of 250 mA at 28V dc max.

Finally, AMP's low-profile (0.22 in.) 6000 Series switches come in BCO, BCD and hexadecimal codings in packages measuring less than 1 in. in diameter. They feature a fully enclosed design that provides environmental protection. Available in screwdriver-, knob- and thumbwheel-actuation versions, the switches have gold-over-nickel-plated phosphor-bronze contacts. **EDN**

Article Interest Quotient (Circle One)
High 476 Medium 477 Low 478



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Snap-Action Pushbuttons

Dust and moisture are sealed out via an internal silicon rubber rolling sleeve. There is positive tactile feed-back upon actuation. Electrically, high contact pressure and unique design provides low (.025 ohms max.) contact resistance for

dry circuit. However, the P7 series is rated a big 5 amps for 25,000 cycles. Six circuit and four bezel variations are available in commercial and military versions. Catalog 101 fully illustrates the P7. Write or call for samples.

**OTTO
CONTROLS**

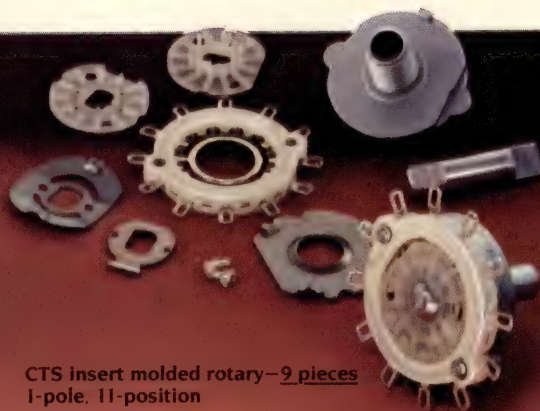
2 East Main Street, Carpentersville, Illinois 60110
Phone: 312/428-7171 Telex: 72-2426

CIRCLE NO 61

Smart engineers have always known that **simplicity equals reliability**



Conventional rotary—47 pieces
1-pole, 11-position



CTS insert molded rotary—2 pieces
1-pole, 11-position

Now you select the rotary selector switch likely to be most reliable

It is very apparent that the CTS rotary selector switch—with only 19% as many separate parts as an ordinary switch—offers greater stability and precision switching even under punishing use or severe shock and vibration. Insert molding locks every CTS terminal in place for positive, precise switching—even after thousands of operations.

Take another look at this picture of reliable performance. Compare the many tiny, fragile pieces in an ordinary switch that can become mis-aligned and cause problems in the field.

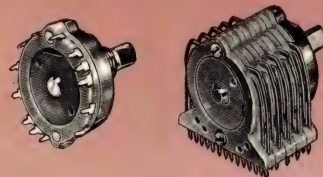
Remember the simple, solid construction of a CTS rotary. You can't make a mistake when you specify the switch that's *built to be most reliable*.

For a complete catalog of reliable CTS rotary selector switches—both stock and custom, call your CTS sales engineer or write: CTS Corporation, 1142 W. Beardsley Ave., Elkhart, IN 46514. Phone: (219) 295-3575; West of Mississippi River: CTS Corporation, 500 Linne Road, Paso Robles, CA 93446. Phone: (805) 238-0350.



CIRCLE NO. 226

CTS offers thousands of PC board rotary switch variations—all with insert molded reliability



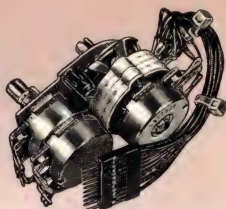
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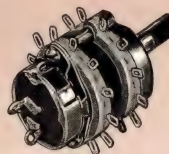
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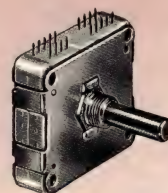
Series 004 Momentary contact switch panel.
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CIRCLE NO. 227



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Type 227 Rotary switch/power switch combination.
Phone: (219) 295-3575
CIRCLE NO. 229



Series 230 20 to 40-position digital rotary switch.
Phone: (219) 295-3575
CIRCLE NO. 230

GETTING THE FACTS ON PROGRAMMABLE MICROPOWER OP AMPS



It was at an SIA dinner meeting that Sherlock Holmes encountered Billy Durham, local reporter for *Electronics Gazette*. Holmes sat in quiet bemusement as the brash young man held court over a Marriott table of eight, not realizing that the attention being paid to him reflected less on his charm than on the power of his publication.

"I'm into an investigative piece on micropower op amps," Durham was saying. "One of my sources who designs portable instrumentation says the linear circuit houses have really overlooked it. Nothing out there works well at low power with the kind of gain you need for battery-powered instruments like handheld voltmeters and portable data acquisition systems."

Billy's audience for the most part only feigned interest, having just sat down from a rigorous cocktail hour, but a few felt compelled to respond.

"I guess the only answer is the LM4250C," one said. "That's currently the industry standard. At least it's cheap, fast, and has a programmable supply current."

Suddenly Holmes could hold his silence no longer. "Ah, my friends, but what tradeoffs Billy's source would have to make in performance, whether he uses the LM4250, MC1776, or any of the others of that genre. They are all low in price, but they are also low in performance, particularly when it comes to gain, input offset voltage, CMRR and PSRR."

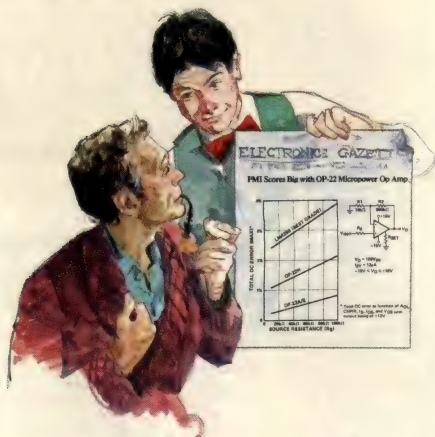
"Then what's the answer, Mr. Holmes?", the intrepid reporter queried.

"I'm no expert, of course," Holmes said, "but I've heard that PMI's new OP-22 programmable micropower op amp is the first to offer the performance specifications of precision op amps like the OP-07 or OP-12 for low-frequency, high-gain applications. As an objective reporter, you should certainly look at this PMI OP-22 data sheet."

As the detective handed it across the table, the house lights dimmed

Holmes walked into the newspaper office and lectured the startled young reporter for his misinterpretation of the facts on PMI's OP-22 programmable micropower op amp.

A contrite Billy Durham showed Holmes his follow-up story on industry acceptance of the OP-22, highlighted by a Page 1 graph tracking dc error vs. source resistance.



and the SIA forecasters began. When Holmes looked again, the young reporter had vanished.

A week later, Holmes sat reading Billy Durham's by-lined report in *Electronics Gazette*.

"I don't believe it, Watson," he cried out.

"How's that, Holmes?" Watson said, looking up from the Rubik's Cube™ that had absorbed him for weeks.

"That reporter we met at the SIA dinner. He garbled the facts by suggesting that 'a usually reliable industry source,' meaning me, I assume, 'said that to achieve precision performance in high-gain instrumentation operating from battery or solar-cell power sources, designers will have to scrap existing designs built around the standard LM4250 or comparable circuits in order to get the precision performance of PMI's new OP-22.'"

"Hmmm," Watson muttered. "Isn't that what you said?"

"Absolutely not," Holmes insisted. "The OP-22 is fully pin-compatible with the 4250, even though it offers an order of magnitude improvement in performance. At least he appears to have the specs right: Programmable supply current, 1 μ A to 400 μ A; single or dual supply operation; input offset voltage, 100 μ V, with drift specified at 0.75 μ V/°C; high CMRR and PSRR of 115dB. And, of great significance—high open-loop gain of 1.8 million."

"Smashing," said Watson.

"Smashing indeed," Holmes replied. "In fact, those are the specs of which legends are made. But young Billy has misled the industry, I'm afraid."

An hour later, Holmes walked into the editorial offices of the *Gazette* and threw the paper on the desk of a very startled Billy Durham, who asked,

EDN JANUARY 6, 1983

"Like my report, Mr. Holmes?"

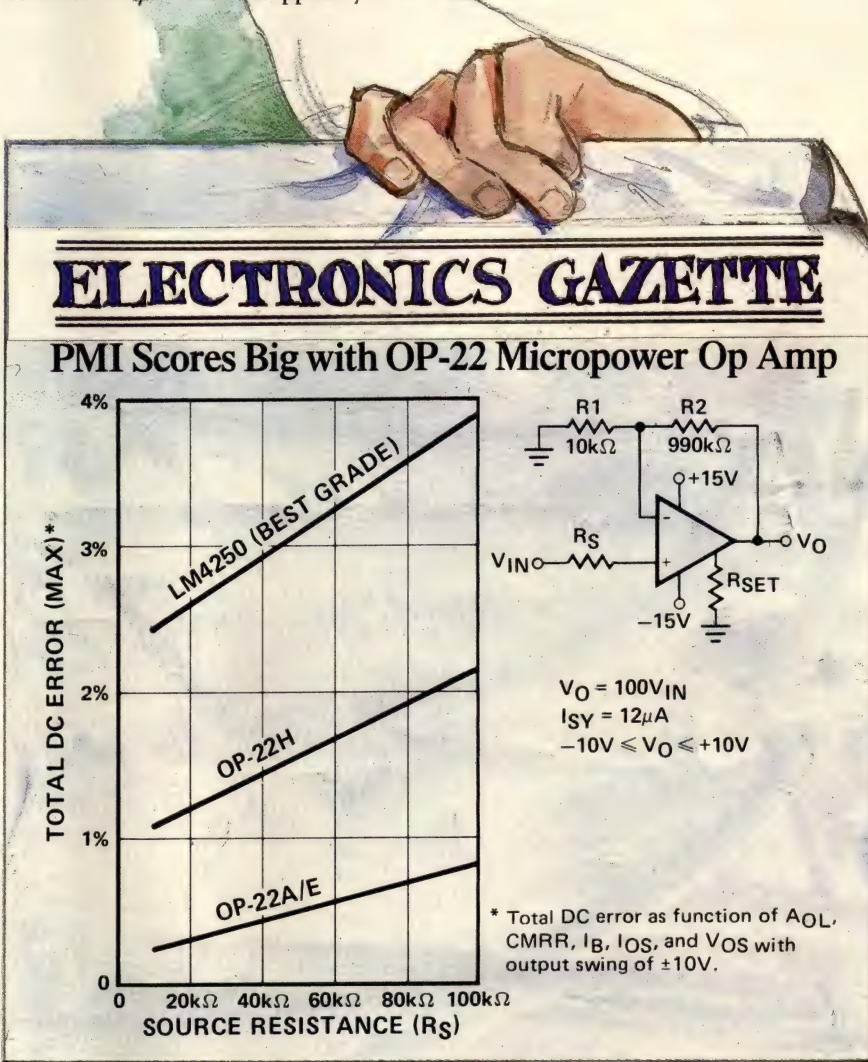
"Your facts are straight, Billy, but your interpretation is wrong. Of course, the OP-22 is ideal for new designs. But its value is enhanced by the fact that it is pin-compatible with the 4250. In fact, I would hazard a guess that in any application where performance is more important than price, there isn't a 4250 socket around that couldn't be upgraded and made more robust with the OP-22. You owe it to your readers to tell them *all* the news that's fit to print, Billy."

It was a full two weeks later that a contrite Billy Durham dropped by

Holmes' office at 221B Bayshore. "I wanted you to be the first to see my follow-up report on the OP-22," he said, proudly displaying the *Gazette's* story on the rapid industry acceptance of the OP-22's versatility and precision performance, highlighted by a graph tracking total dc error vs. source resistance.

"Well done," Holmes said. "You're an honor to your profession, Billy."

"Thanks, Mr. Holmes. And I appreciate your help so much that you'll notice this week I promoted you from *usually* reliable source to *highly* reliable source."



(TO SEE ALL THE EVIDENCE SHERLOCK HOLMES HAS GATHERED ON PMI'S NEW OP-22 PROGRAMMABLE MICROPOWER OP AMP, JUST CIRCLE THE READER SERVICE NUMBER OR CALL YOUR PMI REPRESENTATIVE.)



Precision Monolithics, Incorporated
 1500 Space Park Drive
 Santa Clara, CA 95050
 (408) 727-9222
 TWX: 910-338-0528
 Telex: 172-070

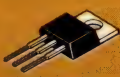
In Europe contact:
Precision Monolithics, Incorporated
 % BOURNS AG
 ZUGERSTRASSE 74
 6340 Baar, Switzerland
 Phone: 042/33 33 33
 Telex: 868 722

In Japan contact:
Nippon PMI
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CIRCLE NO 200



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	IRF440 8A, 0.85Ω, 500V	VN5001D/IRF830 4.5A, 1.5Ω, 500V						
	VNP002A* 6.5A, 1.5Ω, 500V	IRF820 2.5A, 3Ω, 500V						
	VN5001A/IRF430 4.5A, 1.5Ω, 500V							
350-400	IRF350 15A, 0.3Ω, 400V	IRF740 10A, 0.55Ω, 400V						
	IRF340 10A, 0.55Ω, 400V	VN4000D/IRF730 5.5A, 1.0Ω, 400V						
	VNM001A* 8A, 1.0Ω, 400V	IRF720 3A, 1.8Ω, 400V						
	VN4000A/IRF330 5.5A, 1.0Ω, 400V							
120-240	IRF250 30A, 0.085Ω, 200V	IRF640 18A, 0.18Ω, 200V	VN2406B 0.8A, 6Ω, 240V	VN2406M 0.3A, 6Ω, 240V	VN2406L 0.21A, 6Ω, 240V			
	IRF240 18A, 0.18Ω, 200V	IRF630 9A, 0.4Ω, 200V		VN2410M 0.25A, 10Ω, 240V	VN2410L 0.16A, 10Ω, 240V			
	IRF230 9A, 0.4Ω, 200V	IRF620 5A, 0.8Ω, 200V						
	IRF220 5A, 0.8Ω, 200V	VN2406D 1.4A, 6Ω, 240V						
60-100	IRF150 40A, 0.055Ω, 100V	IRF540 27A, 0.085Ω, 100V	IRFF120 6A, 0.30Ω, 100V	VP1008M 0.37A, 5Ω, -100V	VP1008L 0.23A, 5Ω, -100V	VN88AF 1.5A, 4Ω, 80V	VQ1006P 0.40A, 4.5Ω, 90V	VQ1006J 0.40A, 4.5Ω, 90V
	IRF140 27A, 0.085Ω, 100V	VN1000D/IRF530 12A, 0.18Ω, 100V	2N6661 0.9A, 4Ω, 90V	VN0808M 0.35A, 4Ω, 80V	VN0610L 0.2A, 5Ω, 60V	VN80AF 1.3A, 5Ω, 80V	VQ2006P 0.41A, 5Ω, -90V	VQ2006J 0.41A, 5Ω, -90V
	VN1000A/IRF130 12A, 0.18Ω, 100V	IRF520 8A, 0.30Ω, 100V	2N6660 1.1A, 3Ω, 60V	VN0606M 0.4A, 3Ω, 60V	VN2222L 0.15A, 7.5Ω, 60V	VN66AF 1.7A, 3Ω, 60V	VQ1004P 0.46A, 3.5Ω, 60V	VQ1004J 0.46A, 3.5Ω, 60V
	IRF120 8A, 0.3Ω, 100V	VN88AD 1.7A, 4Ω, 80V	VN67AB 1A, 3.5Ω, 60V	VN10KM 0.3A, 5Ω, 60V		VN67AF 1.6A, 3.5Ω, 60V	VQ1000P 0.225A, 5.5Ω, 60V	VQ1000J 0.225A, 5.5Ω, 60V
	2N6658 1.9A, 4Ω, 90V	VN0600D 16A, 0.12Ω, 60V	VP1008B 0.9A, 5Ω, -100V	VN2222KM 0.25A, 7.5Ω, 60V			VQ2004P 0.41A, 5Ω, -60V	VQ2004J 0.41A, 5Ω, -60V
	VN0600A 16A, 0.12Ω, 60V	VN66AD 1.9A, 3Ω, 60V						
30-40	VN0400A 16A, 0.12Ω, 40V	VN0400D 16A, 0.12Ω, 40V	2N6659 1.4A, 1.8Ω, 35V	VN0300M 0.7A, 1.2Ω, 30V		VN46AF 1.6A, 3Ω, 40V	VQ1001P 0.85A, 1.0Ω, 30V	VQ1001J 0.85A, 1.0Ω, 30V
	2N6656 2A, 1.8Ω, 35V	VN0300D 2.5A, 1.5Ω, 30V	VP0300B 1.3A, 2.5Ω, -30V	VP0300M 0.48A, 2.5Ω, -30V		VN40AF 1.3A, 5Ω, 40V	VQ2001P 0.60A, 2Ω, -30V	VQ2001J 0.60A, 2Ω, -30V
Specialty Products (N- and P-Channel Quad Arrays)							VQ3001P ±30V, 3Ω Total	VQ3001J ±30V, 3Ω Total
							VQ7254P ±20V, 3Ω Total	VQ7254J ±20V, 3Ω Total

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HARRIS PRECISION MONOLITHIC DACs PRODUCT SUMMARY

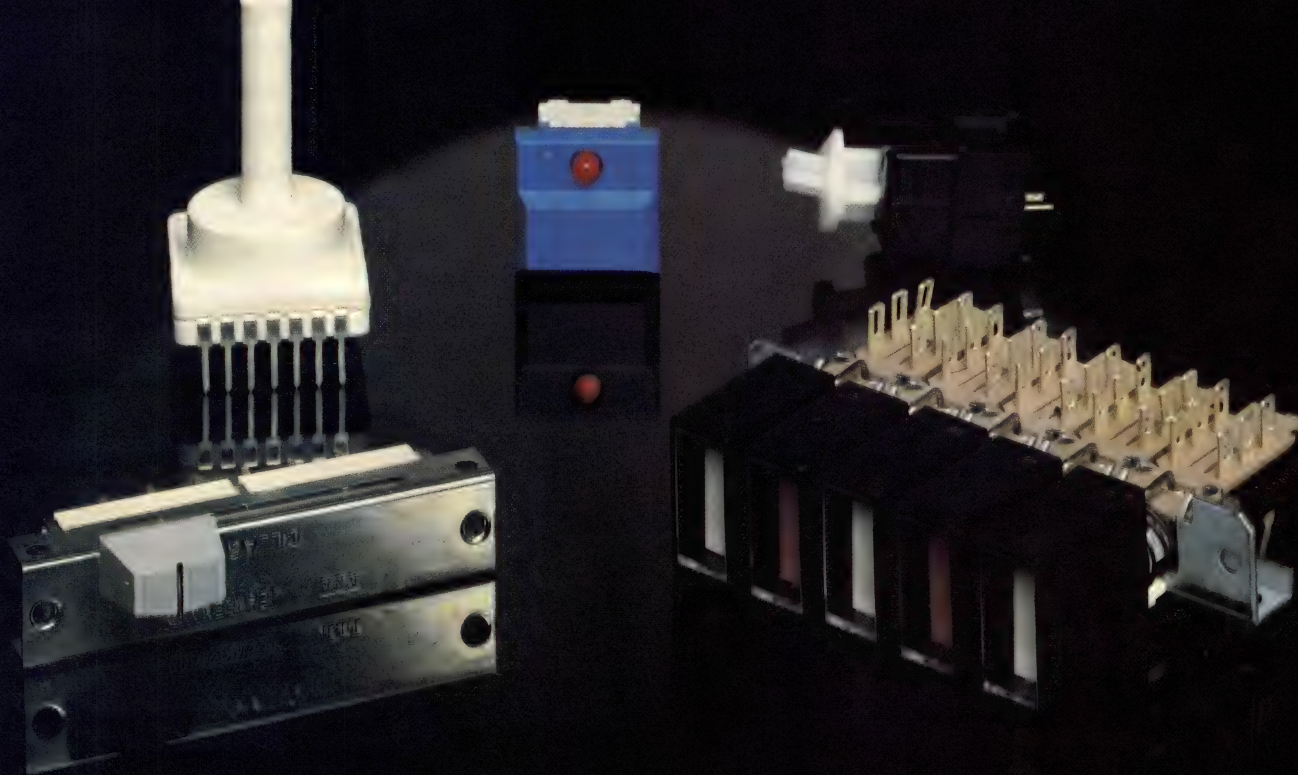
Harris Part Number	Resolution (Bits)	Differential Nonlinearity (Typ. 25°C)	Settling Time (Typ.)	Configuration	Product Highlights
HI-DAC16B HI-DAC16C	16 16	$\pm .0015\%$ $\pm .003\%$	1.0 μ s 1.0 μ s	IDAC IDAC	Monolithic. New industry standard. For linearity/speed.
HI-5680V HI-5680I	12 12	$\pm .01\%$ $\pm .01\%$	1.5 μ s 300 ns	VDAC IDAC	Monolithic. Higher speed, lower power. Superior replacements for full DAC 80/85/87 family.
HI-5660A HI-5660	12 12	$\pm .005\%$ $\pm .01\%$	300 ns 300 ns	IDAC IDAC	Excellent linearity, cost-effective replacement for AD566A.
HI-565A	12	$\pm .01\%$	350 ns	IDAC W/Ref.	AD565A direct replacement.
HI-562A	12	$\pm .01\%$	300 ns	IDAC	Industry standard.
HI-DAC80I	12	$\pm .01\%$	300 ns	IDAC	Bare-bones, cost-effective, DAC 80-type die.
HI-7541	12	$\pm .01\%$	700 ns	MDAC	Superior replacement for AD7541.
HI-5610	10	$\pm .05\%$	85 ns	IDAC	Faster settling. Excellent linearity.
HI-5618A HI-5618B	8 8	$\pm .1\%$ $\pm .2\%$	65 ns 65 ns	IDAC IDAC	Faster settling. Excellent linearity.

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Schadow **ITT**

Use comparator ICs in new and useful ways

You can use the unique differential-input/digital-output characteristics of comparators to implement a wide range of circuit functions.

Jim Williams, National Semiconductor Corp

Perhaps the most underrated and underutilized of monolithic ICs, comparators are among the most flexible and universally applicable components in your design arsenal. With their differential linear inputs and very-fast-switching digital outputs, these devices can help you implement unusual circuit functions at favor-

able cost and low component count compared with other approaches. Examples ranging from a shaft-angle encoder to a V/F converter show how you can exploit comparators' unique abilities.

Variable capacitor makes shaft-angle encoder

If, for example, you need to convert a shaft angle to a digital bit stream, you can employ **Fig 1's** comparator-

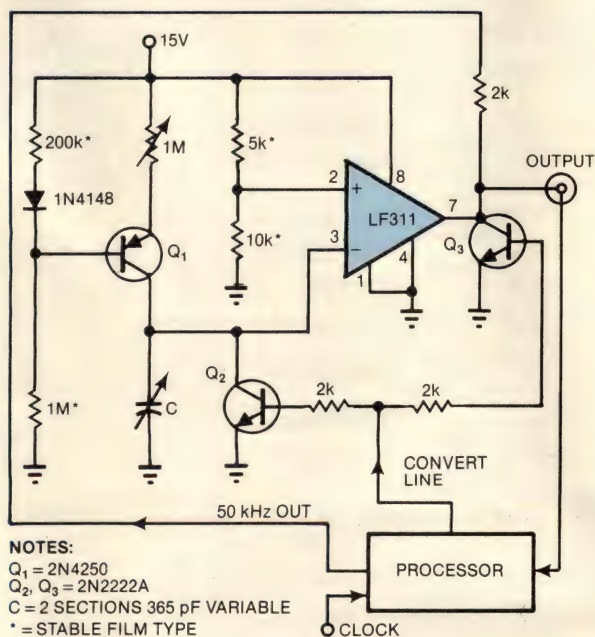
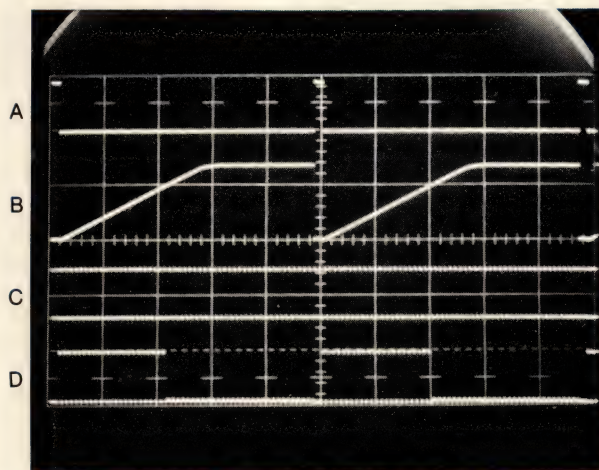


Fig 1—Employing a variable capacitor and a comparator, a single-supply circuit yields a pulse burst—triggered by a Convert-line HIGH-to-LOW transition—whose duration is a $\pm 0.1\%$ linear function of the capacitor's shaft angle.



TRACE	VERTICAL	HORIZONTAL
A	5V/DIV	200 μ SEC/DIV
B	10V/DIV	200 μ SEC/DIV
C	5V/DIV	200 μ SEC/DIV
D	5V/DIV	200 μ SEC/DIV

Fig 2—When the linear charging ramp (trace B) of Fig 1's variable capacitor reaches 10V, it signals a comparator to shut off the trace D output pulse burst.

Obtain shaft-angle readings with a comparator-based circuit

based circuit. It uses a standard AM-radio dual 365-pF variable air capacitor to generate a controlling-processor-triggered constant-frequency pulse burst. The burst's duration—or the number of pulses it contains—indicates shaft position to within a $\pm 0.1\%$ typ accuracy. Moreover, the capacitor has essentially infinite life—unlike potentiometers, which can wear quickly and require frequent replacement in high-usage applications such as video arcade games.

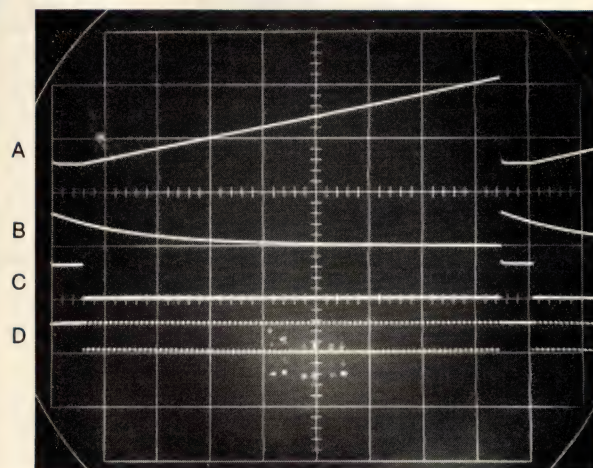
In operation, transistor Q_1 and associated components form a ground-referred current source that linearly charges the variable capacitor. When the controlling processor needs a shaft-angle conversion, it drives the Convert line HIGH (Fig 2, trace A), turning Q_2 on and discharging the capacitor. Concurrently, Q_3 turns on, forcing the circuit output to zero.

To continue the conversion, the processor pulls the Convert line LOW, and the constant-current-source-driven capacitor voltage begins to ramp linearly toward the 15V supply (Fig 2, trace B). This Convert-line HIGH-to-LOW transition simultaneously unclamps the LF311's output, thus triggering a pulse burst by causing the processor's clock (Fig 2, trace C) to appear as a serial bit stream at the output (Fig 2, trace D).

The circuit continues to transmit this bit stream until the capacitor's voltage crosses the level established by the 5-k Ω /10-k Ω resistor divider; at that point the comparator output clamps, inhibiting pulses. Note that each Convert-line HIGH-to-LOW transition initiates an updated bit-stream output.

The circuit is insensitive to supply shifts because the

resistor-divider trip point and the current-source reference are ratiometrically related. The FET-input comparator does not appreciably load other circuit components, so linearity is excellent. With a standard variable air capacitor (General Radio Type 722) substi-



TRACE	VERTICAL	HORIZONTAL
A	0.5V/DIV	1 mSEC/DIV
B	0.1V/DIV	1 mSEC/DIV
C	5V/DIV	1 mSEC/DIV
D	10V/DIV	1 mSEC/DIV

Fig 4—The number of pulses between bit-stream gaps in the Fig 3 circuit's output (trace D) is a linear function of temperature.

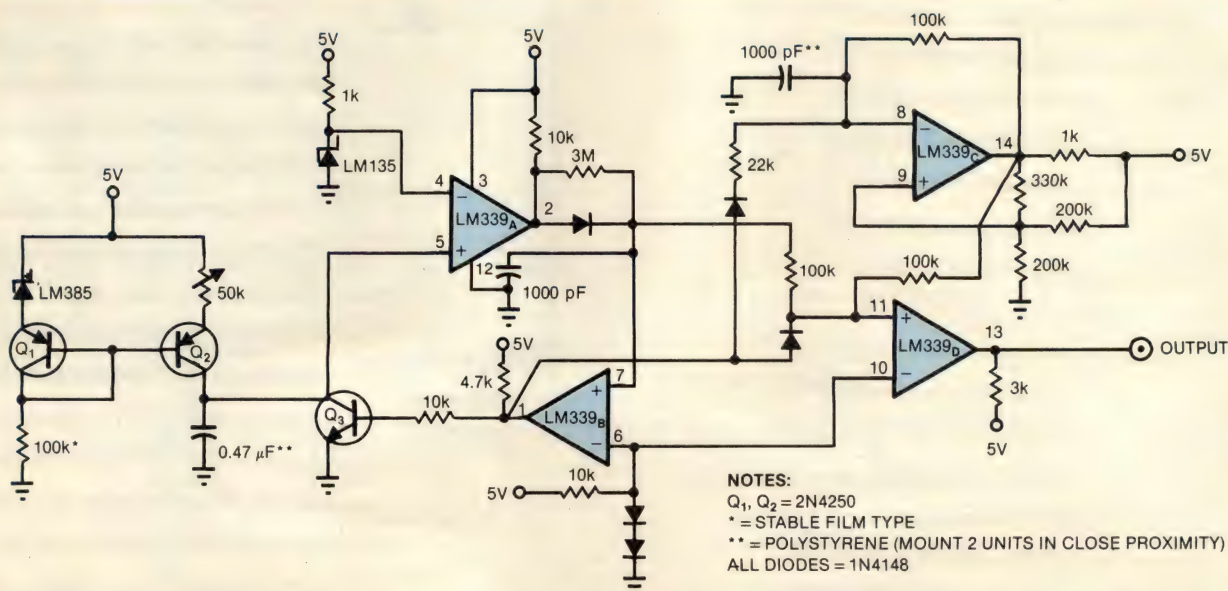


Fig 3—Furnishing an output pulse count proportional to temperature, this LM135-sensor-based circuit requires no external clock. A gap in the output bit stream indicates the end of conversion.

Temperature-sensing scheme uses a 4-comparator IC

voltage finally decays below the 2-diode-drop value at LM339_B's negative input, Q₃ turns off, ramping begins and the cycle repeats.

The oscillation frequency varies inversely with the LM135's output voltage. The ramping time, however, is directly—and linearly—proportional to the LM135's output. While the ramp is running, LM339_B's output is LOW, and LM339_C, which functions as a 10-kHz clock, biases LM339_D, providing the circuit's output. When LM339_A's output goes HIGH, the 100-k Ω resistor path from LM339_A to LM339_D's positive input in turn forces LM339_D's output HIGH (Fig 4, trace D).

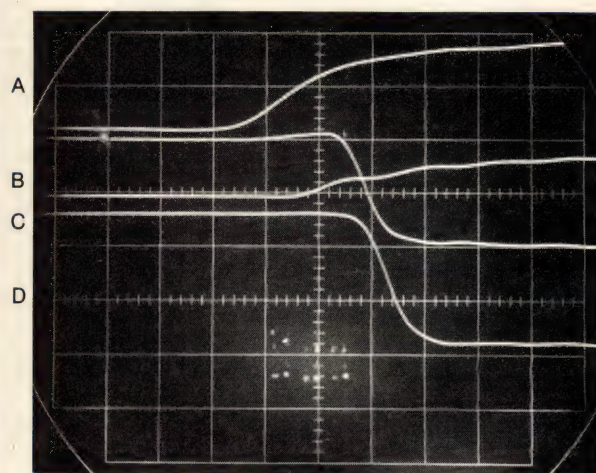
Reinforcing feedback results when LM339_B's output goes HIGH and applies bias through the diode path to LM339_D's positive input. This condition lasts until the 1000-pF-capacitor voltage decays to a value sufficiently low for the cycle to repeat. The 22-k Ω resistor/diode path from LM339_B's output to LM339_C's negative input synchronizes the 10-kHz clock to the circuit's ramp-reset sequence, thereby averting a ± 1 -count uncertainty in the output data.

A monitoring processor can use the gap in the circuit's output bit stream to synchronize itself to the temperature data. To calibrate the circuit, measure the voltage at the LM135 and adjust the 50-k Ω potentiometer so that the number of bits in each burst relates numerically to this voltage (eg, 2.98V=298 bits).

Linearize a platinum RTD with comparators

If, instead of an LM135 sensor, you're using platinum

RTDs (resistance temperature detectors) to take advantage of their extremely wide operating-temperature ranges and their long-term stability under adverse environmental conditions, consider the Fig 5 linearizing



TRACE	VERTICAL	HORIZONTAL
A	5V/DIV	10 nSEC/DIV
B	50 mA/DIV	10 nSEC/DIV
C	5V/DIV	10 nSEC/DIV
D	10V/DIV	10 nSEC/DIV

Fig 7—The fast shutdown action of Fig 6's circuit results in power cutoff (trace D) within 30 nsec of an overload occurrence. Note the beginning of the overload (trace B) at about four horizontal divisions from the left of the screen.

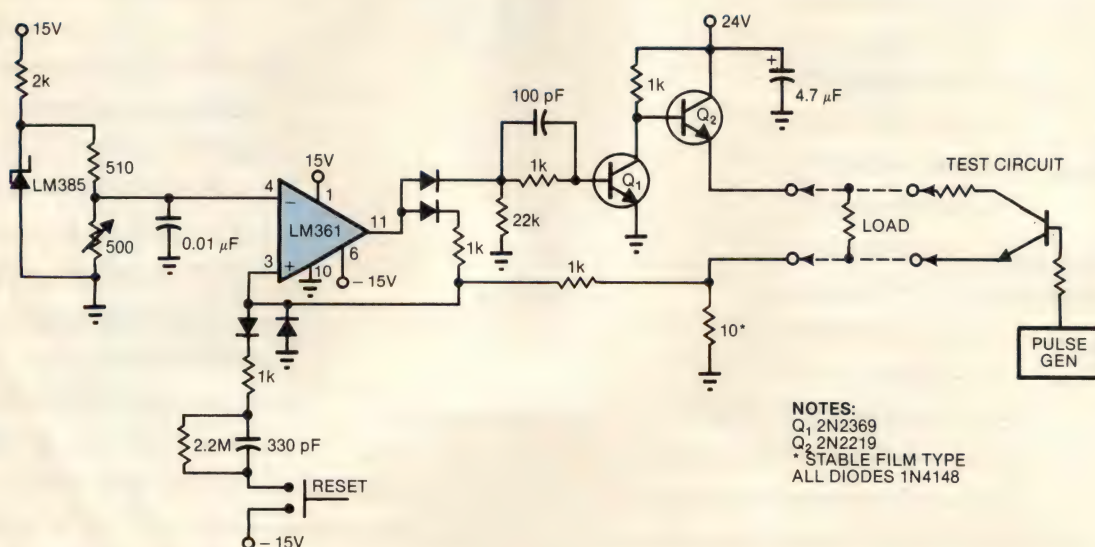


Fig 6—A fast-acting power-shutdown circuit can protect sensitive components. The one shown here employs a comparator and a 10 Ω sense resistor to establish a 100-mA trip point.

circuit. It overcomes an RTD's inherent nonlinearity ($>6^\circ$ error from 0 to 400°C) by using an LM339 quad comparator to apply a 4-section breakpoint correction. In contrast to other RTD-linearizing circuits, Fig 5's design needs no calibration.

Because of the RTD sensor's positive temperature coefficient, op amp LF353_A's output rises with increasing temperature. Summing the output with a constant current at LF353_B's negative input results in a 0V LF353_B output at 0°C ; this output increases as a direct but nonlinear function of the RTD's temperature.

LF353_B's temperature-dependent output drives the positive inputs of the LM339 comparators and provides the input to the output gain stage, LF351_C. The threshold voltages at the LM339 negative inputs cause the respective comparators to switch at the LM353_B voltages corresponding to 100, 200, 300 and 350°C .

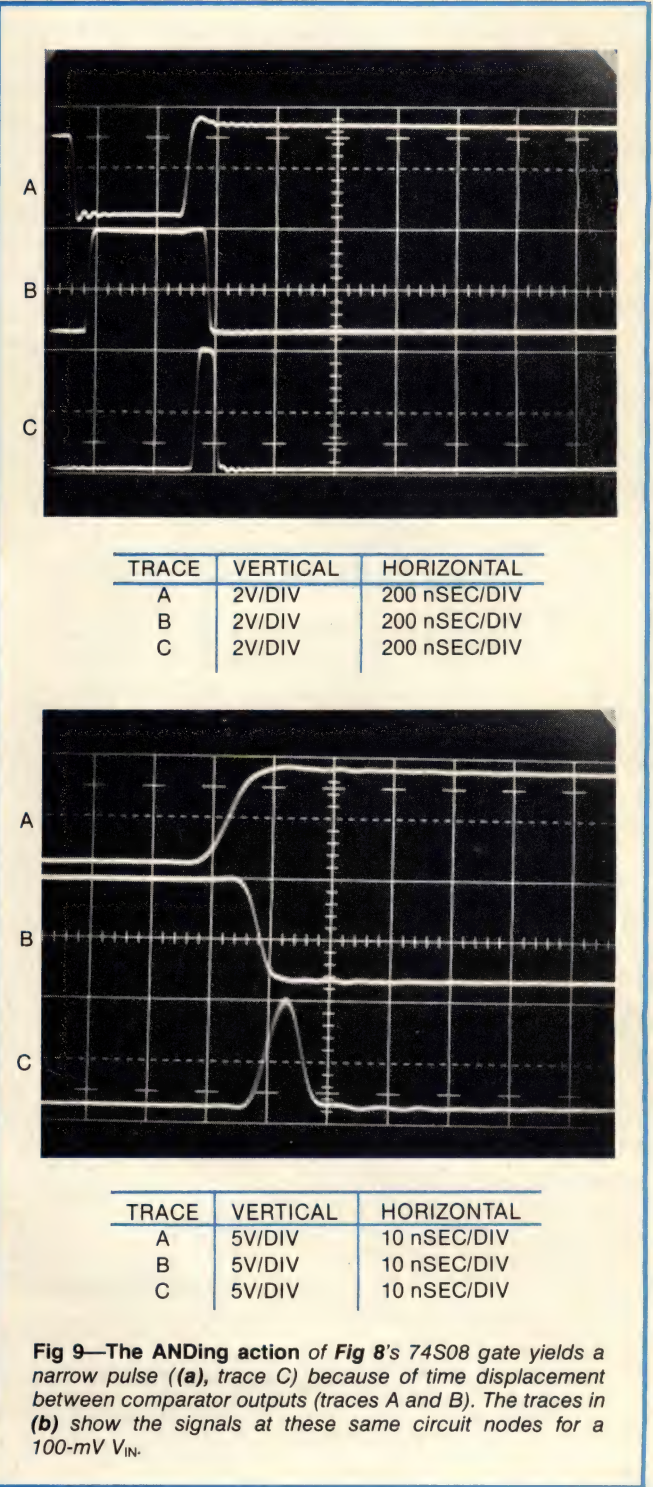
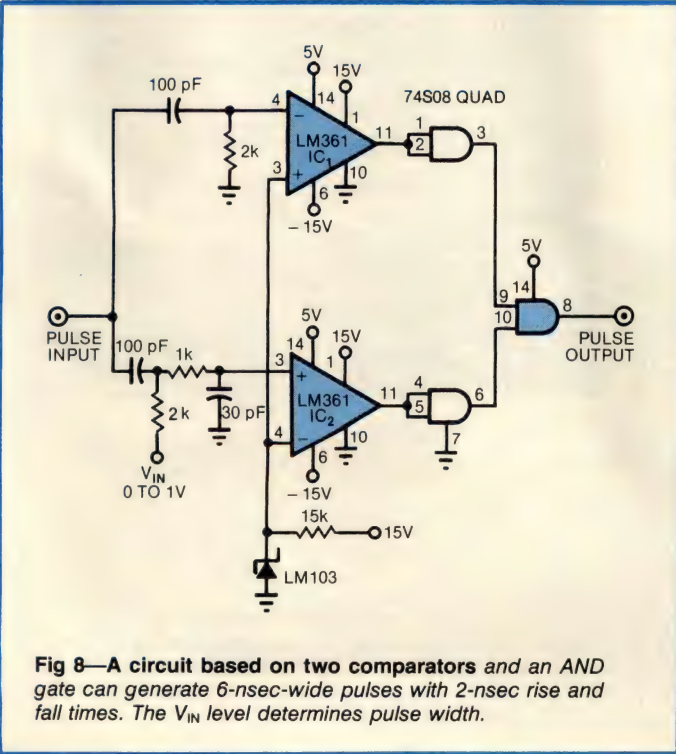
When a comparator output switches HIGH, it switches in gain- and offset-changing resistors via the LF1331 JFET switches. The four slight gain adjustments compensate for the RTD's nonlinearity, and the introduced offsets ensure a monotonic increase in output as temperature rises. The $0.05\text{-}\mu\text{F}$ capacitors at the LM339 outputs prevent chattering at the trip points; the $1\text{-}\mu\text{F}$ capacitor in the LF351's feedback loop eliminates transient switching signals from the output.

If you use the Fig 5 circuit values and RTD sensor, you can obtain $\pm 0.15^\circ\text{C}$ accuracy over 0 to 400°C with no trimming of any kind.

Do you have need to protect expensive components in

a system—perhaps, for example, during the final phases of trimming and calibration? If so, consider the Fig 6 circuit—it shuts down power within 30 nsec of an overload occurrence (in this case, for load currents greater than 100 mA).

When the current is less than or equal to 100 mA, the LM361's output is LOW, Q_1 is OFF and emitter follower



Comparator high-speed switching eases pulse-generation tasks

Q_2 sources power to the load and the 10Ω sense resistor. When an overload occurs (in this case via the test circuit, whose output appears in Fig 7, trace A), the current through the 10Ω sense resistor begins to increase. (Note the slight load-current rise in Fig 7, trace B.)

This rise in current produces a corresponding voltage increase at the LM361's positive input. The comparator's output then rises (Fig 7, trace C) and drives Q_1 through a heavy feedforward network. Although this network degrades the LM361's output rise time somewhat, Q_1 responds very quickly and clamps Q_2 's base to ground, causing load voltage (Fig 7, trace D) to immediately decay to zero.

As noted, the total elapsed time from overload onset to circuit shutdown is 30 nsec. Once the shutdown has occurred, the resistor-diode network from the LM361's pin 11 to pin 3 provides latching feedback to keep power

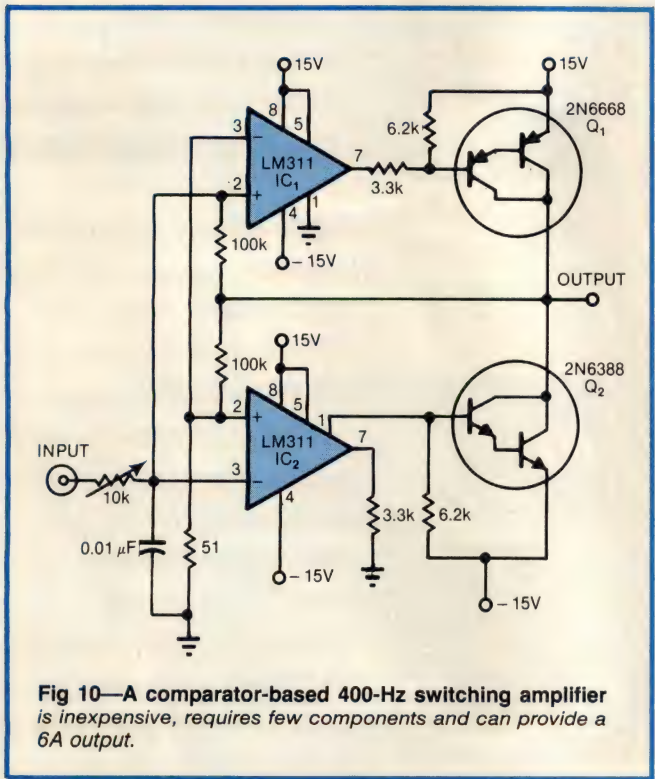
differentiator networks generate a pair of pulses with slightly different durations; the comparators and a Schottky TTL gate extract the difference between two widths and present it as a single fast-rise-time pulse at the circuit output.

When you apply a positive input pulse, the two 100-pF/2-k Ω differentiator networks yield positive outputs. When the positive-going steps exceed the 2V threshold established by the LM103, both LM361s switch output states. For a 0V control input, the differentiator networks and the LM361s respond simultaneously, and both output transitions line up.

As you increase the control voltage, however, the spike produced by IC_2 's differentiator arrives at the 2V threshold earlier than does that of IC_1 . IC_2 also normally takes longer to decay through the 2V threshold, appearing to lead to a situation in which IC_2 's output would remain HIGH longer and switch earlier than would IC_1 's.

IC_2 's 30-pF/1-k Ω network, however, provides a delay that shifts the IC_2 output so that IC_1 's leading and trailing edges occur first (Fig 9a, traces A and B). The length of time between the comparator outputs' edges depends on the input control voltage.

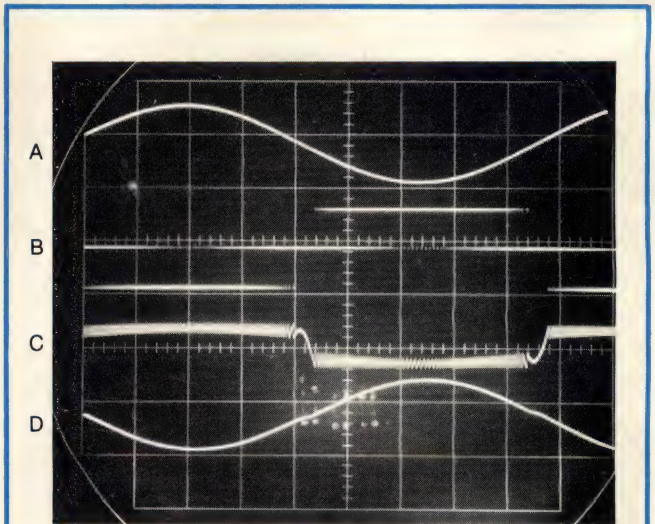
For the Fig 8 circuit, a 0 to 1V control range produces a trailing-edge timing difference of 0 to 100 nsec. The



off the load. The reset pushbutton causes a negative spike to appear at the LM361's positive input, breaking the latching feedback and allowing the loop to function normally again. Use the 500 Ω potentiometer to set the trip point at the desired value (for the Fig 6 circuit, 1V=100 mA).

Comparators make 2-nsec pulse generator

Similarly benefiting from the LM361's high-speed performance, the Fig 8 ultra-high-speed pulse generator furnishes voltage-controllable pulse widths. Its

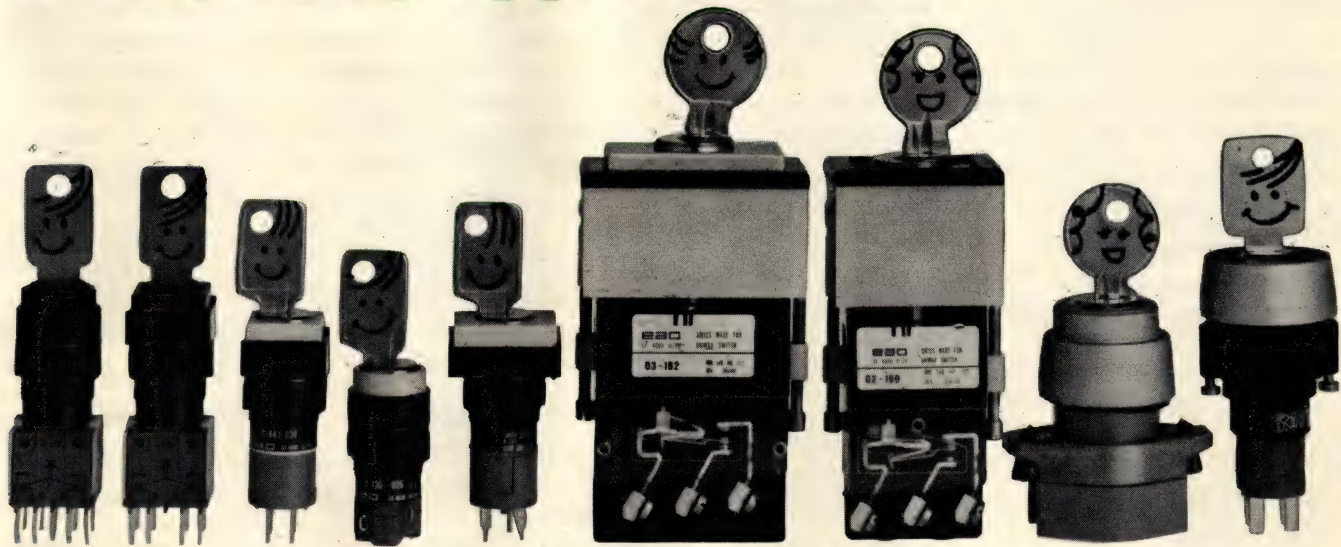


TRACE	VERTICAL	HORIZONTAL
A	2V/DIV	200 μ SEC/DIV
B	20V/DIV	200 μ SEC/DIV
C	100 mV/DIV	200 μ SEC/DIV
D	20V/DIV	200 μ SEC/DIV

Fig 11—The power envelope of the Fig 10 switching amplifier's output (trace D) is sinusoidal when the circuit is driven by a sine-wave input (trace A). Note the high-frequency charging and discharging of the circuit's 0.01- μ F capacitor (trace C).

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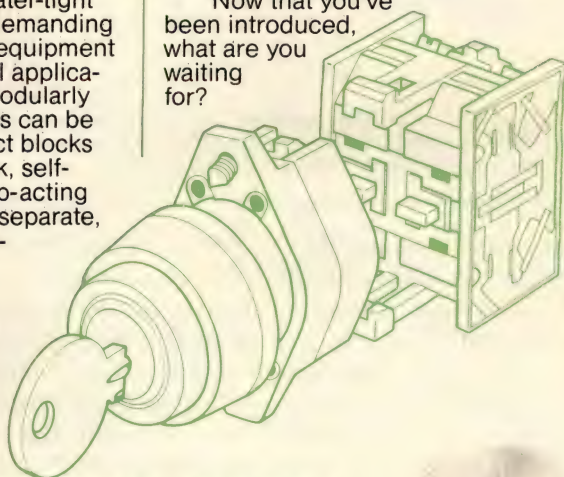
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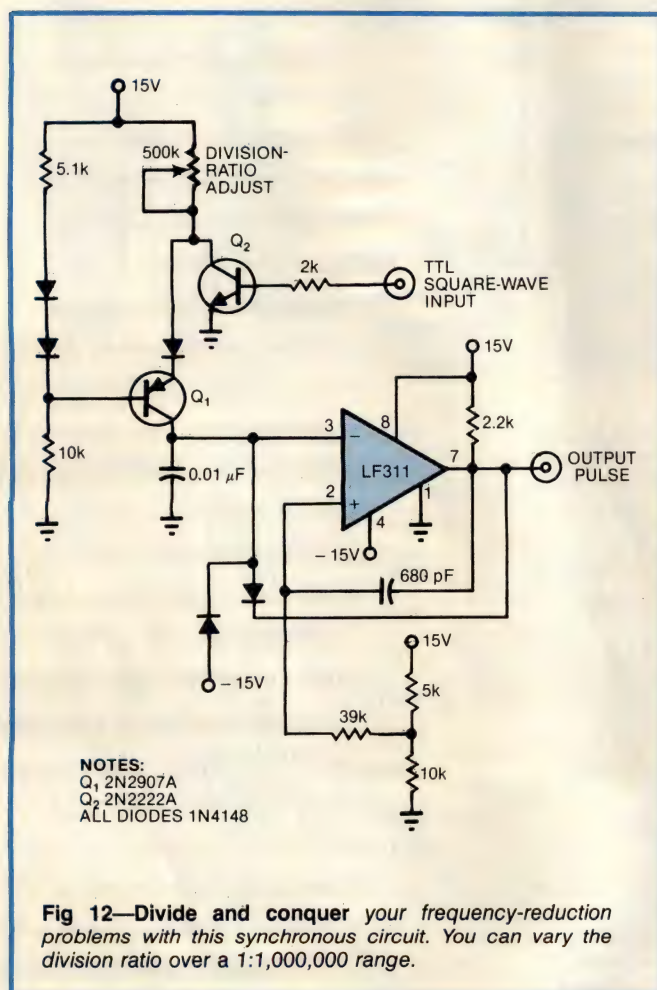
CIRCLE NO 63

Comparator circuit handles frequency-division chores

DM74S08 ANDs the two comparators' outputs to obtain the single-pulse circuit output (Fig 9a, trace C).

The gate and comparator switching speeds limit the minimum pulse width to 6 nsec; rise and fall times are approximately 2 nsec. **Fig 9b** shows an example of the high-speed operation that the **Fig 8** circuit can achieve (control input=100 mV). Traces A and B represent IC₁ and IC₂ outputs, respectively; trace C is the circuit's output pulse.

If you need a simple, inexpensive 400-Hz amplifier, consider the **Fig 10** circuit. It uses $\pm 15\text{V}$ supplies.



provides full bipolar swing and has a 1.5-kHz full-power bandwidth with a 6A pk output capability.

If the input voltage is negative, IC₂'s output is LOW (note that IC₂ operates in an emitter-follower mode, so its output is in phase with its negative input), cutting Q₂ off. Concurrently, IC₁'s output goes LOW, turning Q₁ on and thereby driving the load and the 100-k Ω resistors connected to the comparators' positive inputs. This feedback produces a small voltage at IC₁'s negative input.

When the 0.01- μ F capacitor charges to a level high

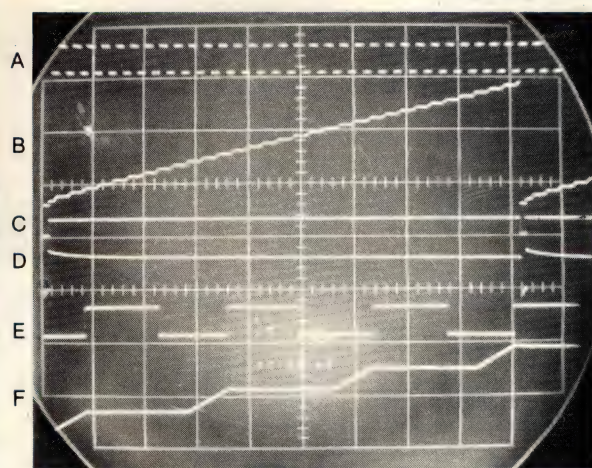
enough to offset the negative input, IC₁'s output changes state, turning Q₁ off. At this point, the input draws current from the capacitor, forcing IC₁'s positive input to a lower state and consequently driving IC₁'s output LOW again, turning Q₁ on.

The switching action occurs continuously; repetition rate depends on the input voltage. For positive inputs, IC₂ and Q₂ perform similar action. To avoid cross-current conduction in the output transistors, tie the comparators' offset-adjust terminals to the 15V supply.

Fig 11 trace B shows the circuit output resulting from the trace A input; the trace C waveform represents current flow in and out of the capacitor. (Think of the IC₂ pin 3 point as a digitally driven summing junction.) Trace D is a lightly filtered version of trace B; it clearly shows that the circuit output has a sinusoidal power envelope. You can vary the amplifier gain with the 10-k Ω input potentiometer.

Divide frequencies over a 1:1,000,000 range

Using the **Fig 12** circuit, you can divide a frequency over a $1:10^6$ range, adjustable via a single potentiometer. Moreover, the output frequency you obtain is synchronously related to the input frequency. You can use this circuit to obtain simultaneous oscilloscope observations of low-frequency signals and the fast clock



TRACE	VERTICAL	HORIZONTAL
A	10V/DIV	100 μ SEC/DIV
B	5V/DIV	100 μ SEC/DIV
C	50V/DIV	100 μ SEC/DIV
D	20V/DIV	100 μ SEC/DIV
E	10V/DIV	10 μ SEC/DIV
F	0.2V/DIV	10 μ SEC/DIV

Fig 13—Using a step-charging technique that results in the trace B capacitor voltage, **Fig 12**'s circuit yields an output frequency proportional to and synchronized with an input signal's frequency (trace A). In the example shown here, the output (trace C) contains a pulse after 32 input pulses.

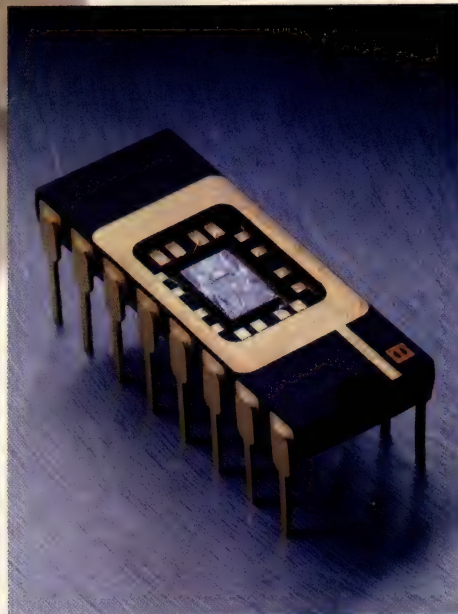
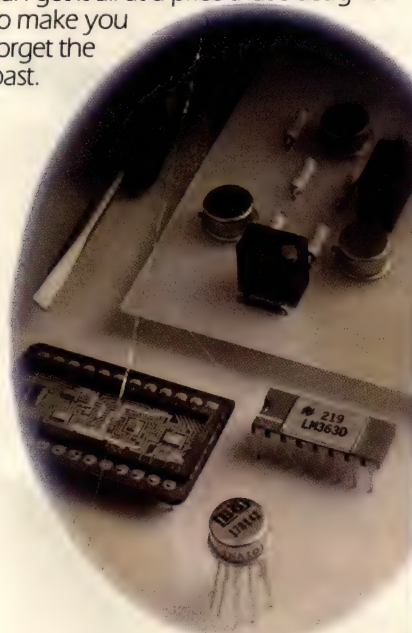
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Manipulate pulses with comparator-based circuits

from which they're derived or to synchronously trigger an A/D converter at a variable rate.

The circuit functions by step-charging a capacitor with a switched current source and using a comparator to determine when to reset the capacitor. **Fig 13**, trace B, shows the step-charging waveform; each time the pulse input (**Fig 13**, trace A) goes LOW, a current-source pulse causes a capacitor-voltage positive step. You can control the step height—and therefore the division ratio—with the 50-k Ω potentiometer.

When the staircase waveform reaches the voltage at the LF311's positive input, the comparator output goes LOW (**Fig 13**, trace C) and stays LOW until the positive feedback through the 680-pF capacitor ceases. The delay produced by this feedback ensures a complete reset for the 0.01- μ F capacitor, which discharges through the steering diode into the comparator output.

The diode connected from LF311 pin 3 to -15V provides first-order compensation for the steering diode's leakage effects during the charge cycle. **Fig 13**, trace D, shows the waveform at the LF311's positive input. Traces E and F show in an expanded time scale the relationship between the input waveforms and the step-charged ramp.

When using this circuit, remember that although the output frequency is always synchronously related to the input frequency, its absolute value can vary with time and temperature. Typically, the trip point—hence, the output frequency—moves back and forth along the horizontal portion of a step at low division ratios and changes from step to step at high ratios.

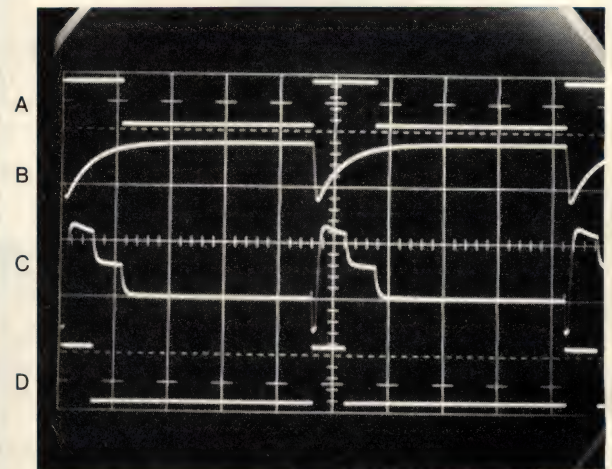
Overcome TTL multivibrators' shortcomings

If you've used TTL monostables, you've undoubtedly noticed their poor input triggering characteristics and limited dynamic range with a given timing capacitor. The **Fig 14** circuit surmounts these limitations to

provide a true level-triggered input and a single-resistor-programmable 10,000:1 output-pulse range. It delivers a preprogrammed output pulse width regardless of the input pulse duration. (The minimum input trigger-pulse width is, however, 3 μ sec.)

When you apply an input pulse (**Fig 15**, trace A) to the circuit, LM393_A's output goes LOW (**Fig 15**, trace B), producing reinforcing feedback for its own positive input (**Fig 15**, trace C). This causes LM393_B's output to go HIGH, providing additional feedback to LM393_A's positive input via the 1-M Ω resistor.

When the 50-pF capacitor ceases to provide feedback



TRACE	VERTICAL	HORIZONTAL
A	10V/DIV	200 μ SEC/DIV
B	5V/DIV	200 μ SEC/DIV
C	1V/DIV	200 μ SEC/DIV
D	5V/DIV	200 μ SEC/DIV

Fig 15—The output pulse width (trace D) of **Fig 14**'s monostable circuit is insensitive to the input width (trace A).

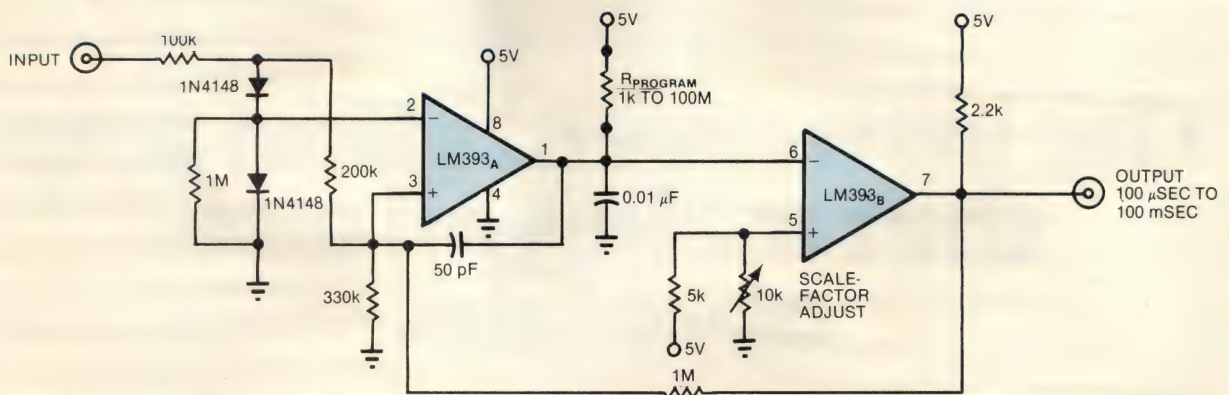


Fig 14—Better than a multivibrator, this monostable circuit provides a true level-triggered input and a 10,000:1 output pulse range. You program the output pulse width with one resistor.

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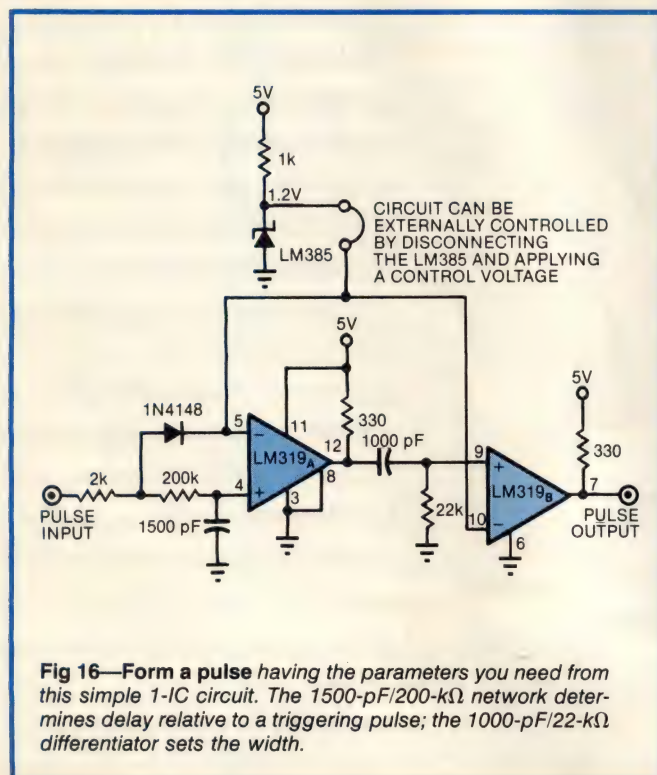
to LM393_A's positive input, this comparator's output goes HIGH, allowing the 0.01- μ F timing capacitor to charge (Fig 15, trace B). When the capacitor voltage exceeds LM393_B's positive input voltage, LM393_B's output (Fig 15, trace D) goes LOW, terminating the output pulse.

With the 0.01- μ F timing capacitor, you can obtain output pulse widths of 10 μ sec to 100 msec, with a scale factor (trimmable with the 10-k Ω potentiometer) of 100 Ω / μ sec.

Get variable width and delay with one IC

If you need a known-width pulse that's delayed with respect to another pulse, consider the Fig 16 circuit. It works from one 5V supply and requires only one dual-comparator IC.

When you apply a TTL input (Fig 17, trace A), LM319_A's output stays LOW until the 1500-pF capacitor at its positive input charges beyond the negative input's 1.2V level. The resistor-diode clamp from the circuit input to LM319_A's pin 5 provides immunity to input-amplitude variations.



When LM319_A's output goes HIGH (Fig 17, trace B), the transition is coupled via the 1000-pF/22-k Ω differentiator to LM319_B's positive input (Fig 17, trace C), causing LM319_B's output to rise and stay HIGH (Fig 17, trace D) until the differentiator output drops below the 1.2V level at LM319_B's negative input.

You can tailor both the delay time and the output

pulse width to your requirements by altering the values of the RC networks. Alternatively, you can control these parameters externally by applying variable voltages to the comparators' negative inputs.

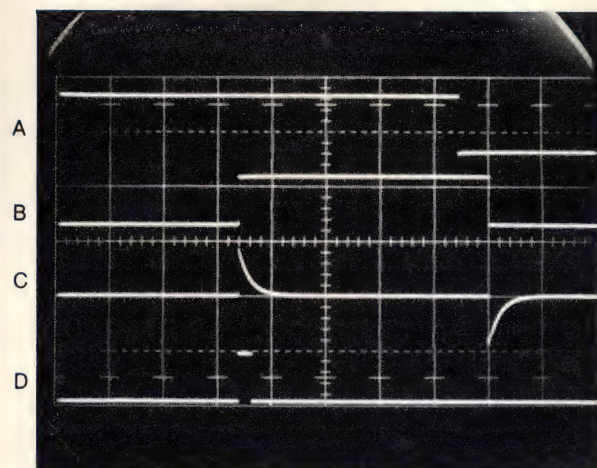
Make an ultrafast V/F converter

Using two comparator ICs, you can build a V/F converter that yields a 5-kHz to 10-MHz output, with better than $\pm 1\%$ linearity, from a 0 to 5V input. The LM160's 20-nsec propagation delay allows Fig 18's circuit to run much faster than monolithic VFCs.

The LM160's output switches the 50-pF capacitor between a reference voltage (furnished by the LM385) and the comparator's negative input. The comparator's output pulse width is unimportant so long as it permits complete charging and discharging of the capacitor. The LM160 also drives the 5-pF/510 Ω network, providing regenerative feedback to reinforce its output transitions.

When this positive feedback decays, any negative-going LM160 output is followed by a positive-going edge after an interval determined by the 5-pF/510 Ω time constant (Fig 19, traces A and B).

The actual integration capacitor—the 0.01- μ F unit—never charges beyond 100 mV because it's constantly reset by charge dispensed from the switched 50-pF capacitor (Fig 19, trace C). When the LM160's output goes negative, the 50-pF capacitor takes charge from



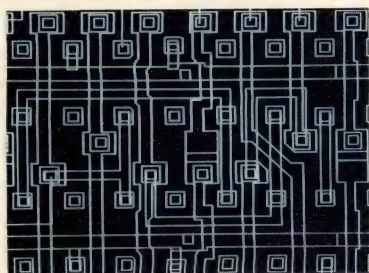
TRACE	VERTICAL	HORIZONTAL
A	5V/DIV	100 μ SEC/DIV
B	5V/DIV	100 μ SEC/DIV
C	5V/DIV	100 μ SEC/DIV
D	5V/DIV	100 μ SEC/DIV

Fig 17—A delayed narrow pulse (trace D) from Fig 16's 1-IC circuit specs delay and width of 340 and 30 μ sec, respectively.

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Two comparator ICs yield a fast, linear VFC

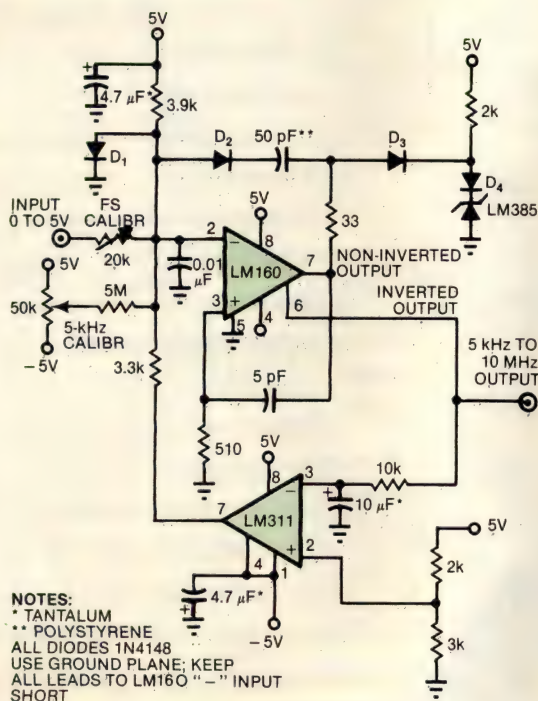
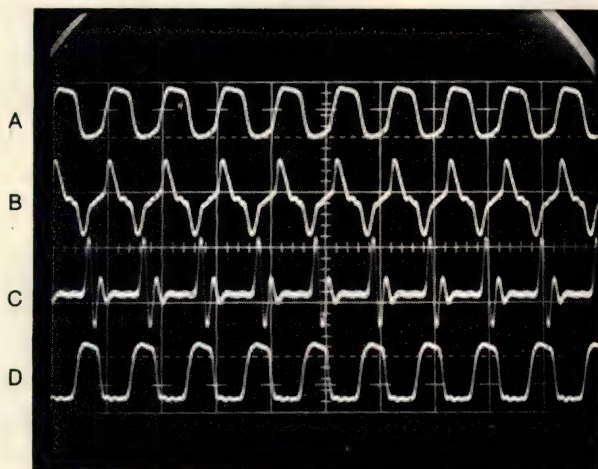


Fig 18—Producing 5-kHz to 10-MHz output, this V/F-converter circuit uses two comparator ICs and features $\pm 1\%$ linearity. The LM160 is the heart of the converter; the LM311 prevents lockup.



TRACE	VERTICAL	HORIZONTAL
A	5V/DIV	100 μ SEC/DIV
B	0.5V/DIV	100 μ SEC/DIV
C	10 mA/DIV	100 μ SEC/DIV
D	5V/DIV	100 μ SEC/DIV

Fig 19—A clean 10-MHz output (trace D) results from an LM160's action in Fig 18's V/F converter. Trace C shows the charge-dispersing current from Fig 18's 50-pF capacitor.

the 0.01- μ F capacitor, resulting in a lower voltage.

The LM160's negative-going output also produces a short negative pulse—via the 5-pF/510 Ω feedback—at its positive input. When this negative pulse decays to a point where the positive input is just higher than the negative input, the 50-pF capacitor again receives a charge, and the entire cycle repeats. Diodes D₁ and D₂ compensate for diodes D₃ and D₄, minimizing temperature drift.

The LM160's inverted output (Fig 19, trace D) serves as circuit output and also drives the LM311 comparator circuit to prevent LM160 lockup. Without it, any condition (such as startup and input overdrive) that allows the 0.01- μ F capacitor to charge beyond its normal operating point could cause the LM160's output to go to the -5V rail and stay there.

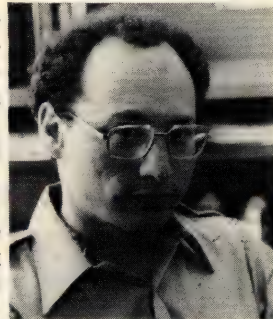
The LM311 prevents lockup by pulling the LM160's negative input toward -5V. The 10- μ F/10-k Ω network determines when the LM311 switches on. When the VFC runs normally, the 10- μ F capacitor charges to a negligibly small voltage, holding the LM311 off. The LM160's inverted output stays HIGH if the VFC stops running (if lockup occurs), forcing the LM311 to turn on and restarting the circuit.

To calibrate the circuit, apply a 5V input and adjust the 20-k Ω potentiometer for a 10-MHz output. Then apply 2.5 mV and adjust the 50-k Ω potentiometer for a 5-kHz output. When building this circuit, use a ground plane and good grounding techniques and locate the components associated with the LM160 inputs as close as possible to the inputs.

EDN

Author's biography

Jim Williams, now a consultant, was applications manager in National Semiconductor's Linear Applications Group (Santa Clara, CA), specializing in analog-circuit and instrumentation development, when this article was written. Before joining the firm, he served as a consultant at Arthur D Little Inc and directed the Instrumentation Development Lab at the Massachusetts Institute of Technology. A former student of psychology at Wayne State University, Jim enjoys tennis, art and collecting antique scientific instruments in his spare time.



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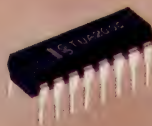
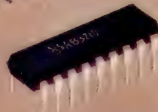
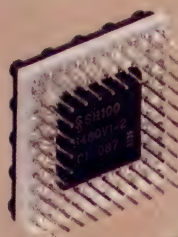
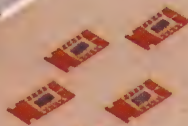
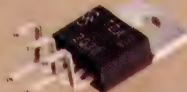
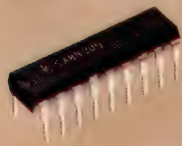
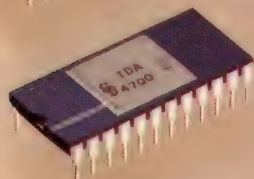
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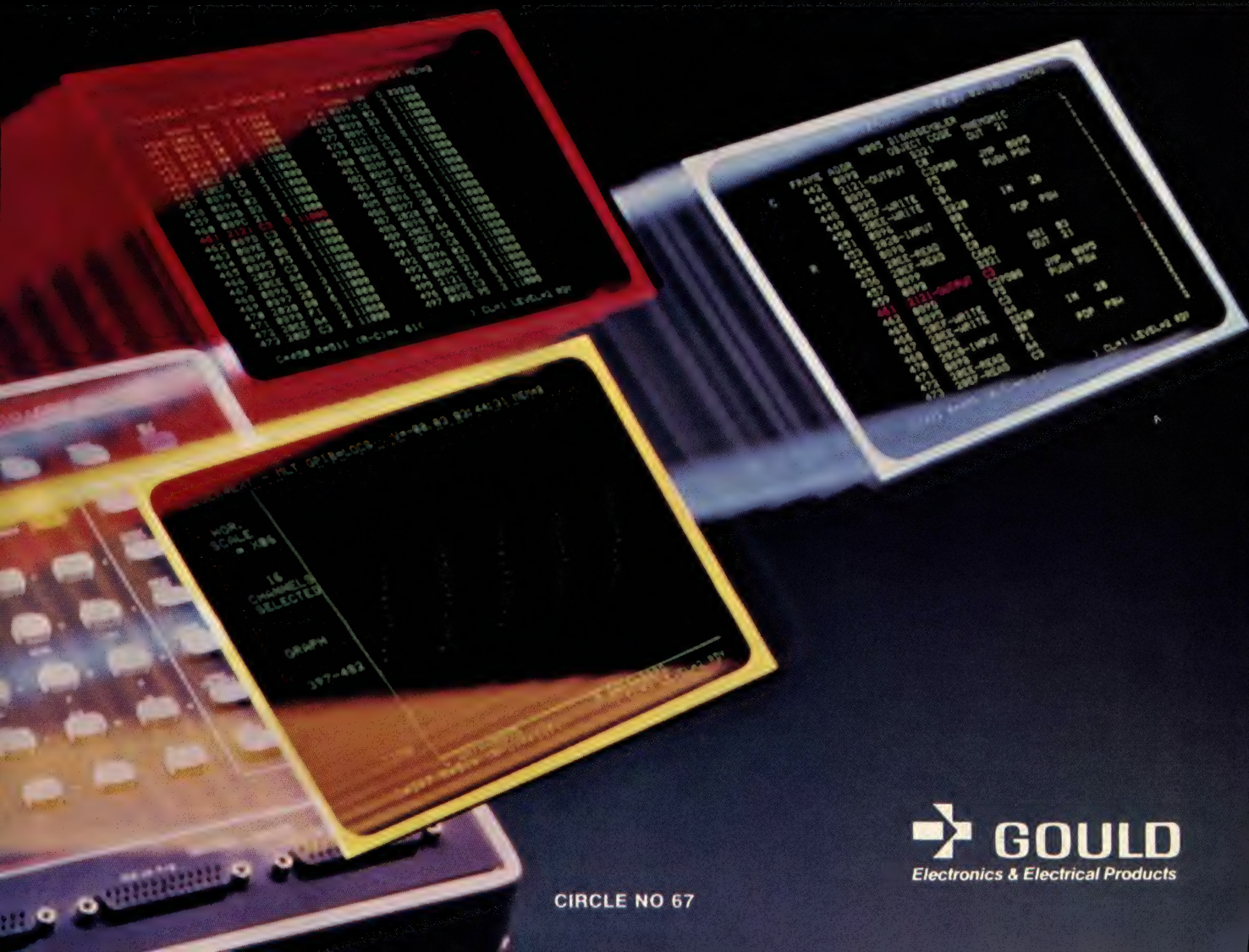
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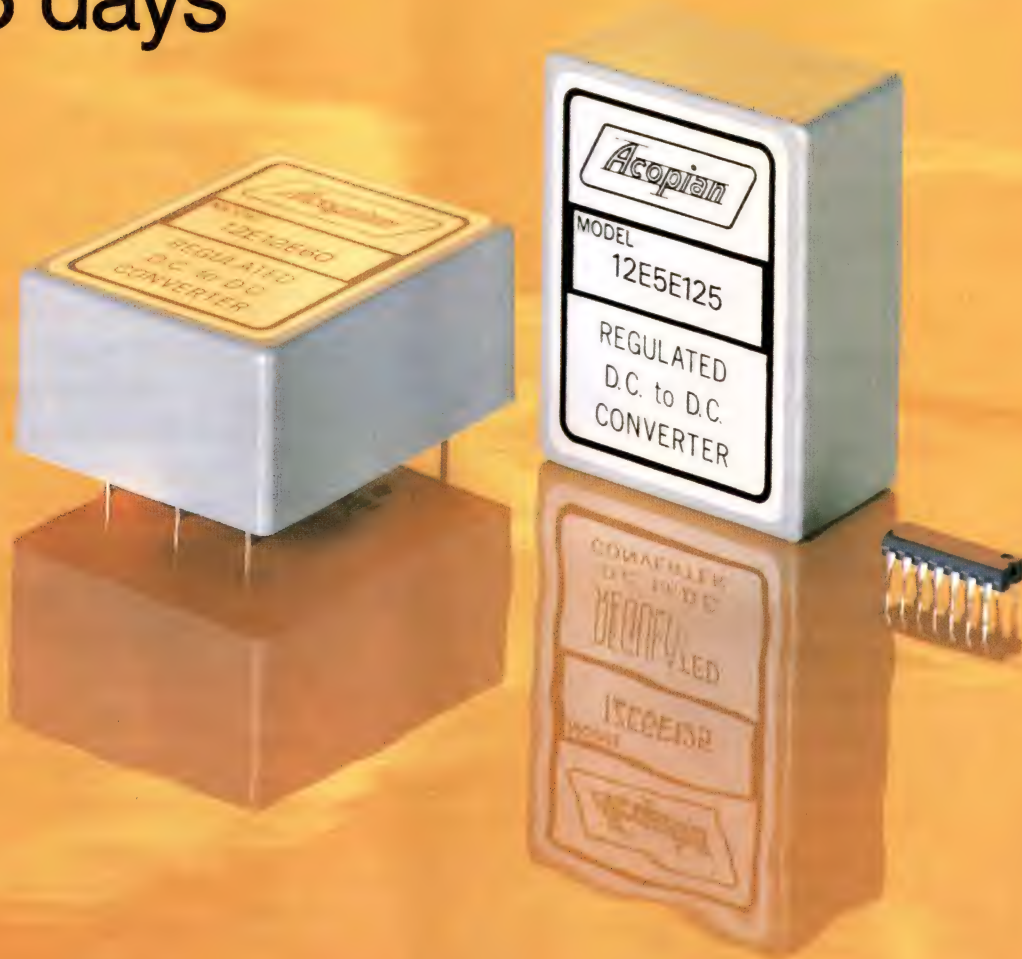
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Built-in overflow detection speeds 16-bit μ P arithmetic

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Karl Gutttag, Texas Instruments Inc

By including overflow-detection capability in their hardware, the 99000 and 9995 μ Ps eliminate the need for overflow-checking instructions that slow program execution, increase program size and unnecessarily complicate the software engineer's job. And to minimize modifications to existing programs employing conventional detection techniques, programmers can selectively disable the μ Ps' hardware error detection.

To understand how hardware-implemented overflow detection is helpful, first consider the circumstances that cause overflow. For example, inadvertently dividing an integer by zero results in overflow because the operation yields a number too large to be represented in the computer's 16-bit (or other fixed-size) word. Similarly, overflow can occur in floating-point versions of processors (such as the 99110 version of the 99000 family) when a numerical result is outside the range of numbers expressible in the floating-point format.

Other common occurrences of overflow are associated with the two's-complement representation of numbers. This type of overflow can occur in several different circumstances in which the result of a binary operation on a specific data type (8-, 16- or 32-bit data, for instance) can't be saved in a word of the same length.

Review the basics of two's-complement math

Consider, for example, that in signed two's-complement arithmetic, the leading (leftmost) bit of an integer indicates the number's sign—ZERO for positive and ONE for negative—and the remaining bits complete the numerical value.

The bits following the leading ONE of a negative number don't specify a simple integer, however; a negative number results from its positive counterpart

being complemented and then incremented. For example, a 16-bit two's-complement representation of the number 1 (0000000000000001₂) complements to 1111111111111110₂ and then increments to 1111111111111111₂, the two's-complement representation for -1.

The two's-complement scheme is useful because it allows an unambiguous representation of the number 0 and because it also works with the ordinary rules of integer arithmetic. For instance, a two's-complement 0

```
99000 EXAMPLE
STST R5                ;READ STATUS REGISTER
ORI R5, 0020           ;SET BIT 10 (OVERFLOW ENABLE) TO 1
LST R5                ;SET STATUS REGISTER TO CHECK OVERFLOW
AB #BYT1,R1            ;ADD BYTE (OVERFLOW AUTOMATICALLY CHECKED)
SB #BYT2,R1            ;SUB BYTE (OVERFLOW AUTOMATICALLY CHECKED)
A #WORD1,R2            ;ADD WORD (OVERFLOW AUTOMATICALLY CHECKED)
DEC R2                ;DECREMENT (OVERFLOW AUTOMATICALLY CHECKED)
AM #DOUBLE,R3,4        ;32 BIT ADD (OVERFLOW AUTOMATICALLY CHECKED)
DIVS #DIVISOR,R3       ;DIVIDE (OVERFLOW AUTOMATICALLY CHECKED)

CODE SIZE - 32 BYTES
EXECUTION TIME WITH OVERFLOW CHECKING - 13.0 MICROSECONDS (24 MHZ INPUT CLOCK)

,8086 EXAMPLE
ADD BYT1,BH            ;ADD BYTE
INTO                   ;INTERRUPT (TRAP) IF OVERFLOW
SUB BYT2,BH            ;SUB BYTE
INTO                   ;INTERRUPT (TRAP) IF OVERFLOW
ADD WORD1,CX           ;ADD WORD
INTO                   ;INTERRUPT (TRAP) IF OVERFLOW
DEC CX                ;DECREMENT BY 1
INTO                   ;INTERRUPT (TRAP) IF OVERFLOW
ADD DOUBLE,AX          ;FIRST HALF OF 32 BIT ADD
ADC DOUBLE*2,DX        ;SECOND HALF OF 32 BIT ADD
INTO                   ;INTERRUPT (TRAP) IF OVERFLOW
IDIV #DIVISOR          ;8086 TRAPS IF OVERFLOW ON DIVIDE

CODE SIZE - 36 BYTES (WORD ALIGNED) or 31 BYTES (BYTE ALIGNED)
EXECUTION TIME WITH OVERFLOW CHECKING - 29.3 MICROSECONDS (10 MHZ INPUT CLOCK)

68000 EXAMPLE
ADD B BYT1,D1          ;ADD BYTE
TRAPV                 ;TRAP IF OVERFLOW
SUB B BYT2,D1          ;SUB BYTE
TRAPV                 ;TRAP IF OVERFLOW
ADD WORD1,D2           ;ADD WORD
TRAPV                 ;TRAP IF OVERFLOW
SUBQ #1,D2            ;DECREMENT BY 1
TRAPV                 ;TRAP IF OVERFLOW
ADD L DOUBLE,D3        ;32 BIT ADD
TRAPV                 ;TRAP IF OVERFLOW
DIVS DIVISOR,D3        ;TRAP IF DIVIDE BY ZERO (Automatically)
TRAPV                 ;TRAP IF OVERFLOW ON THE DIVIDE

CODE SIZE - 34 BYTES
EXECUTION TIME WITH OVERFLOW CHECKING - 22.4 MICROSECONDS (10 MHZ INPUT CLOCK)
```

Automatic overflow checking allows fast execution of arithmetic routines running on the 99000. Other μ Ps require inserted instructions to detect overflow.

Conventional overflow checking slows program execution

(0000000000000000₂) complements to 1111111111111111₂ and increments to 0000000000000000₂ again—the desirable result of negation on 0. Likewise, all the other rules for integer arithmetic apply. For instance, $2+2$ (0000000000000010₂+0000000000000010₂) yields 4 (0000000000000100₂), and a number plus its two's-complement number yields 0.

Several situations can result in errors due to arithmetic overflows, however. The addition of two positive 16-bit numbers, for example, can yield a sum that can't be expressed as a signed 16-bit number, causing arithmetic overflow and an apparent negative result. For instance, adding the positive numbers 7100₁₆ and 1F00₁₆ results in 9000₁₆, a negative number, because bit position 15 overflows into the sign bit (position 16). The operation actually requires a 17-bit two's-complement number to represent the result, and conventional carry-detection mechanisms that monitor only the most significant (sixteenth) bit position don't necessarily detect the error.

Similarly, adding two negative 16-bit numbers can produce a positive result:

$$9105_{16} + A316_{16} = 341B_{16}.$$

In this case, the addition causes a carry out of the sign bit, rather than into it as in the previous example.

A third example of overflow involves taking the absolute value of a processor's largest allowable negative integer. The largest negative integer express-

OVERFLOW-DETECTION METHODS

	PROCESSOR	INSTRUCTION	JUMP ON- OVERFLOW	TRAP ON- OVERFLOW	DIVIDE BY- ZERO TRAP	PROGRAMMABLE AUTOMATIC OVERFLOW TRAP
TEXAS INSTRUMENTS	99000 or 9995		*			*
MOTOROLA	68000		*	*	*	
INTEL	8086 or 8088		*	*	*	
NATIONAL SEMICONDUCTOR	6800		*		*	

ible in 16 bits, for example, is 8000₁₆ (-32,768). However, the absolute value (two's complement) of this number is also 8000₁₆, the maximum positive integer being 7FFF₁₆ (32,767). The absolute-value function thus yields an invalid result in this special case.

Finally, arithmetic overflow can result from ordinary division of a signed 32-bit integer by a signed 16-bit integer. Because the dividend's magnitude has a maximum value of 2^{31} and the divisor has a maximum magnitude of only 2^{15} , the quotient's magnitude can be as great as 2^{16} , a number that generates overflow.

Whatever the cause of overflow, its effects can be devastating. Not only does an affected numerical value lose some precision, but a resulting change in an intermediate result can make any ensuing results meaningless.

Different schemes handle overflow

Overflow problems aren't new, however; programmers have handled them since the first days of computing. But minicomputer and mainframe programmers traditionally have written code that checks for

Detecting overflow with hardware

The 99000 μ P contains special overflow-checking hardware that eliminates the need for conditional-jump or conditional-trap instructions after each arithmetic operation. Bit 10 in the μ P's status register controls the capability; if that bit is set, an arithmetic overflow causes the generation of a level-2 interrupt (trap) unless the interrupt mask has previously disabled level 2.

Having control of overflow checking in the status register allows the automatic saving of overflow status with the rest of the program context if an interrupt occurs immediately after the setting of the bit. The 99000 automatically clears bit 10 after saving the status register in response to an

interrupt so that the interrupt routine doesn't start with the overflow interrupt enabled. After the interrupt routine finishes, the μ P restores the program context.

Typically, software sets the overflow-enable bit at the beginning of a critical routine to provide overflow protection. If an overflow occurs, the processor traps to the level-2 interrupt handler, which includes the overflow-handling routine. Because level-2 interrupts automatically switch the 99000 into its Supervisor mode, a user need not provide the overflow-error-handling routines; instead they can be part of the operating-system executive that handles user-program execution.

The 99000 also assists in

multiprecision operations because it has built-in 32-bit instructions. The 8086, as a contrasting example, performs a 32-bit addition with a 16-bit add followed by a 16-bit add-with-carry. This approach would cause significant problems in an automatic - overflow-checking method because the first addition operation can cause a temporary overflow. On the 99000, however, an overflow trap can occur only after the complete 32-bit operation. Likewise, 8-bit operations on the 99000 generate overflow on 8-bit numbers rather than larger ones.

For more information on the 99000, **Circle No 750**.

overflow errors after each arithmetic operation. Some advanced minicomputers have built-in arithmetic overflow-detection circuitry similar to that found on the 99000, but most still rely on the traditional software approach.

The traditional method checks for overflow by executing either a conditional-jump instruction or a conditional-vectored-trap instruction. The jump method causes a direct branch to a correction routine after overflow detection, whereas the trap method branches to a global location where the program derives a correction-routine address from a special table of trap vectors. On most μ Ps, conditional instructions must follow each arithmetic operation, potentially doubling the length of numeric-intensive routines and significantly slowing them as well.

An alternative method of checking for arithmetic overflow involves use of a Sticky flag. The 8087 numeric coprocessor, for instance, clears a flag when it receives a set of operations to perform; the flag then sticks if an overflow occurs during the operations, so a set flag after completion of the operations warns of an error. The obvious disadvantage of this method is the difficulty of determining exactly when the overflow occurred. And without knowing precisely which instruction caused the overflow, recovering from the overflow and determining which operand caused the error are also difficult.

Interrupt method improves handling

On the 99000, the arithmetic-overflow check occurs in hardware under control of a bit in the device's status register (see **box**, "Detecting overflow with hardware"). The 99000's circuitry automatically generates

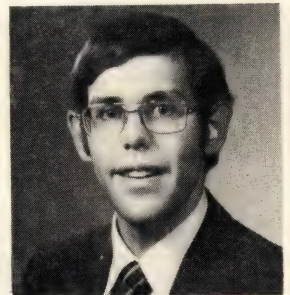
an interrupt whenever overflow occurs, transferring control to a global overflow-error-handling routine as the trap method does but without slowing program execution with repetitive conditional-trap instructions. The elimination of inserted overflow-checking instructions thus allows programs to run at full speed and with no increase in size. And because interrupts occur immediately after overflow (unlike the Sticky-flag method), simple error-recovery methods are possible. Further, because a bit in the status register controls overflow checking, a program that doesn't need automatic checking can selectively disable it.

Because other 16-bit μ Ps (**table**) don't provide such hardware features, the insertion of overflow-checking instructions in arithmetic routines typically results in extended execution times. A benchmark comparison of some times for several popular μ Ps appears in the **figure**.

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Author's biography

Karl Gutttag is a senior member of Texas Instruments's technical staff in Houston. With TI for 5 yrs, he is currently involved in managing graphics-product strategy. Karl holds a BSEE degree from Bradley University and an MSEE from the University of Michigan and lists running and computer history as hobbies.



Article Interest Quotient (Circle One)
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Other overflow considerations

(Ed Note: The following additional points apply to overflow detection and might influence the approach you take in processor selection and program design.)

Sometimes the automatic detection of overflow can be an inconvenience. If an Arithmetic Left Shift operation is used to make a Logical Left Shift and the most significant bit changes during shifting, what might appear to be an arithmetic fault actually isn't. The 99000 allows you to disable overflow checking before such an operation and enable it again

afterward, but this process can entail substantial overhead. Consequently, automatic overflow detection is best suited to situations in which most of the operations involve signed arithmetic. For mixed-mode operations (signed and unsigned), testing for overflow with conditional-jump or conditional-trap instructions is better.

Moreover, you can use a numeric coprocessor to detect overflow on multiprecision operations, but don't forget the overhead involved in transferring numbers back and forth. You can use an

8087 for 32-bit operations, for instance, but the transfer overhead makes it impractical to do individual simple operations such as binary integer addition. In this case, it's better just to check for overflow in your program.

Finally, newer and faster μ Ps can permit faster execution of arithmetic routines even without hardware-implemented overflow detection. The 80186, for example, running with an 8-MHz clock, yields a much lower benchmark time than that reported for the 8086 in this article.

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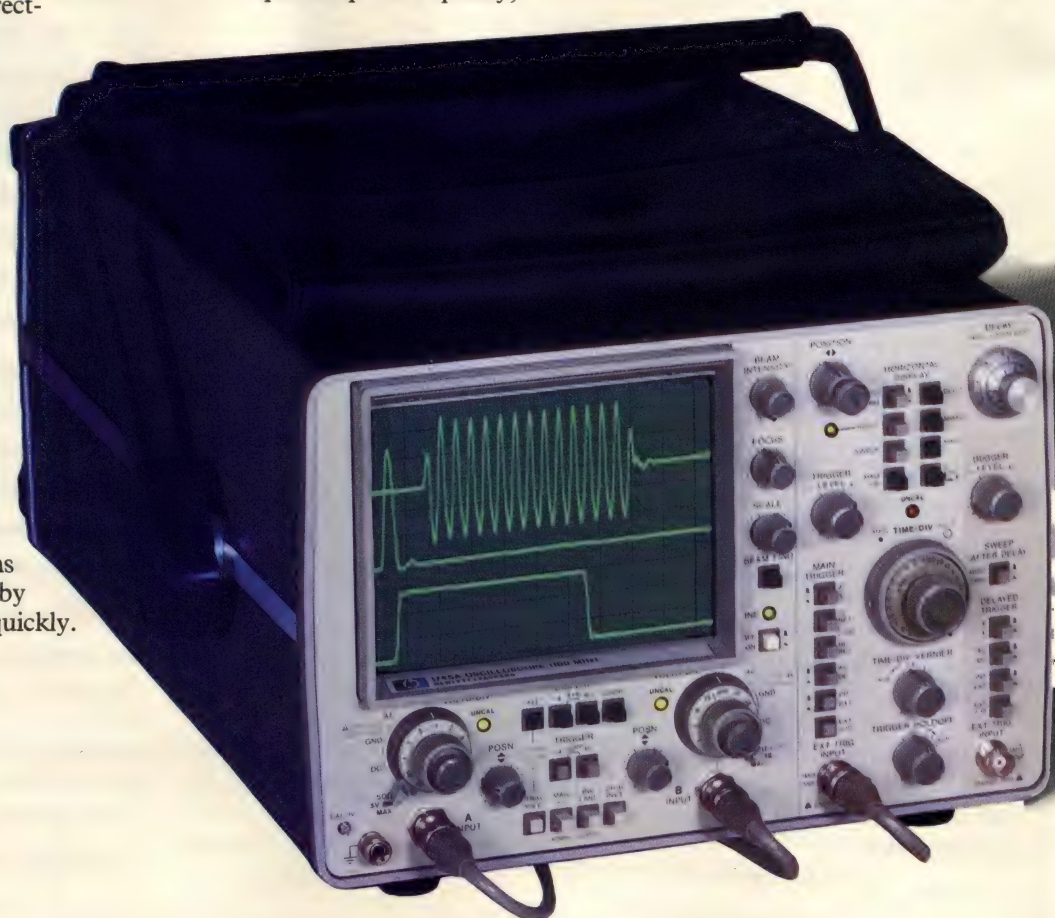
What's more, there's a new contrast filter that makes measurements easy on the eyes. By improving the trace-to-background contrast and eliminating annoying reflections, the filter helps reduce user fatigue. Traces really stand out—even in bright, ambient light. By combining the advantages of a larger screen with improved picture quality,

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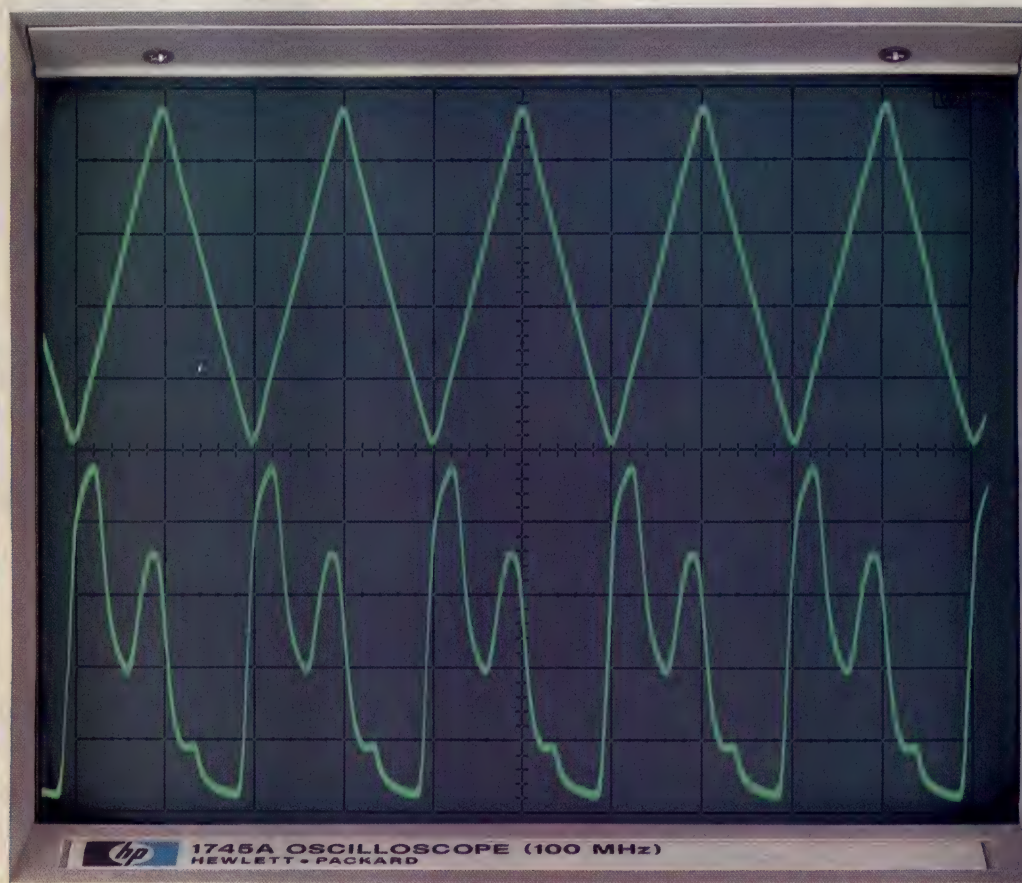
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CIRCLE NO 69

Real-time LSI clock chips ease μ P-control tasks

By providing a grab bag of useful timing outputs compatible with μ P-based systems, multifunction clock ICs can help you implement a variety of timekeeping functions with a minimum of hardware and software overhead.

John C Mein, Professional Engineer

With the LSI real-time clock chips described here, you can significantly reduce your microprocessor-based system's hardware and software requirements. More-

over, the devices provide a variety of useful timekeeping functions difficult to implement otherwise.

The **table** lists clock chips available from Motorola, National Semiconductor, NEC, Holt, Oki, RCA and Western Digital. Although no two of the chips are pin

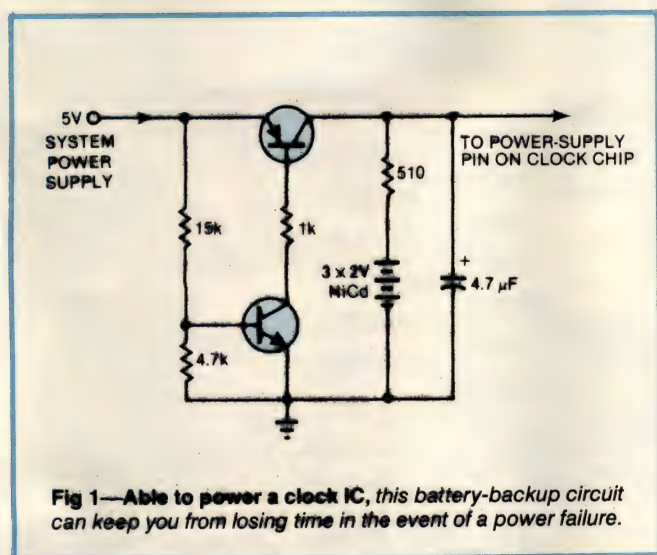
CLOCK-CHIP FEATURES

MANUFACTURER	MODEL	DATA BUS (BITS)	MINIMUM RESOLUTION	MAXIMUM COUNT (YRS)	INTER- RUPTS	PACKAGE PIN COUNT	SECOND, MINUTE, HOUR, DATE AND MONTH INDICA- TION	HOUR INDICA- TION IN 24-HR FORMAT ONLY ②	DAY- OF- WEEK INDICA- TION	YEAR INDICA- TION
MOTOROLA	MC146818P	8	30.517 μ SEC	100	3	24	•		•	•
NATIONAL SEMICONDUCTOR	MM58174AN	4	0.1 SEC	4	1	16	•	•	•	•
NATIONAL SEMICONDUCTOR	MM58167AN	8	100 μ SEC	4	2	24	•	•	•	
NEC	μ PD1990AC	1	1 SEC	1	1	14	•	•	•	
HOLT	HI-8000	8	15.3 μ SEC	128	1	28	•		•	•
OKI SEMICONDUCTOR ①	MSM5832	4	278 μ SEC	99	4	18	•		•	•
OKI SEMICONDUCTOR ①	MSM58321RS	4	278 μ SEC	99	4	16	•		•	•
RCA	CDP1879	8	488 μ SEC	1	1	24	•			
WESTERN DIGITAL	WD2412	8	0.1 SEC	—	2	28	•		•	•

① THESE DEVICES REQUIRE THE USE OF EXTERNAL PULL-UP RESISTORS

② LISTED DEVICES OTHER THAN THE NATIONAL SEMICONDUCTOR AND OKI UNITS PROVIDE A CHOICE OF 12- OR 24-HR FORMATS; IN 12-HR MODES THESE DEVICES FURNISH AM AND PM INDICATIONS.

③ TYPICAL DISSIPATION EQUALS 200 mW.



compatible, they share several common features—for example, they all furnish second, minute, hour, date and month outputs.

All of the chips operate from the μ P's power supply.

To protect against loss of timing data in the event of a power failure, you can provide a backup power source such as a NiCd battery, kept at full charge with a trickle-charging circuit (Fig 1).

The clock chips readily interface with microprocessors, requiring few glue components or none at all. Fig 2 shows, for example, the marriage of Motorola's MC146818 to a typical single-chip μ C. In this example, a 4.194304-MHz crystal provides the timebase; the MC146818 also accepts 1.048576-MHz and 32.768-kHz (commonly used in watches) crystals. With higher frequency crystals, you obtain finer resolution at the expense of higher power dissipation.

Power-down circuit cuts power consumption

One useful application of these devices is a wakeup control for a μ P, to reduce system power consumption in intermittent-use situations. Fig 3 shows a typical configuration using an RCA CDP1879 in an 1802-based system. In this circuit, you use the alarm and power-down features of the CDP1879 to control the μ P's sleep and wakeup states.

AUTOMATIC LEAP-YEAR COMPENSATION	ALARM	CURRENT DRAIN		SUPPLY VOLTAGE		ACCESS TIME (μ SEC)	TECHNOLOGY	PRICE (FOR EACH PLASTIC PACKAGE IN QUANTITIES OF 100)	COMMENTS
		ACTIVE	STANDBY	ACTIVE (V)	STANDBY (V)				
•	•	0.2 TO 5 mA	100 μ A	3 TO 6	3 TO 6	1	CMOS	\$7.25	• DAYLIGHT SAVINGS TIME • PROGRAMMABLE PERIODIC INTERRUPT • SQUARE-WAVE GENERATOR
•		1 mA	10 μ A	4 TO 5.5	2 TO 5.5	0.85	CMOS	\$8.50	• SEPARATE ADDRESS AND DATA BUSES • -55 TO +125°C VERSION
	•	5 mA	20 μ A	4 TO 5.5	2 TO 5.5	1.05	CMOS	\$9.25	• 5-BIT ADDRESS BUS • 3-STATE DATA BUS
		50 μ A	20 μ A	2 TO 5.5	2 TO 5.5	40	CMOS	\$3.50	• SERIAL I/O • 40-BIT TIME DATA
•	•	100 μ A	30 μ A	3 TO 5.25	3 TO 5.25	0.25	CMOS	\$12.65	• MULTIPLEXED ADDRESS/DATA BUS • 1-Hz OUTPUT • PROGRAMMABLE PRESCALER
		500 μ A	30 μ A	4.75 TO 5.25	2.2 TO 7	150	CMOS	\$4.80	• BIDIRECTIONAL I/O BUS • INTERRUPTS AT 1024, 1, 1/60 AND 1/3600 Hz
•		500 μ A	30 μ A	4.5 TO 7	2.2 TO 7	6	CMOS	\$5.65	• BIDIRECTIONAL I/O BUS • INTERRUPTS AT 1024, 1, 1/60 AND 1/3600 Hz
	•	20 μ A TO 4.5 mA	50 TO 200 μ A	4 TO 10.5	4 TO 10.5	0.45	CMOS	\$9.05	• BCD TIME/CALENDAR OUTPUTS • μ P SLEEP/WAKEUP MODE
•	•	③	—	4.5 TO 6.3	—	0.25	NMOS	\$10.20	• POWER-FAILURE FLAG • TTL/CMOS COMPATIBLE



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CIRCLE NO 70

EDN JANUARY 6, 1983

Reduce μ P power consumption with sleep/wakeup control

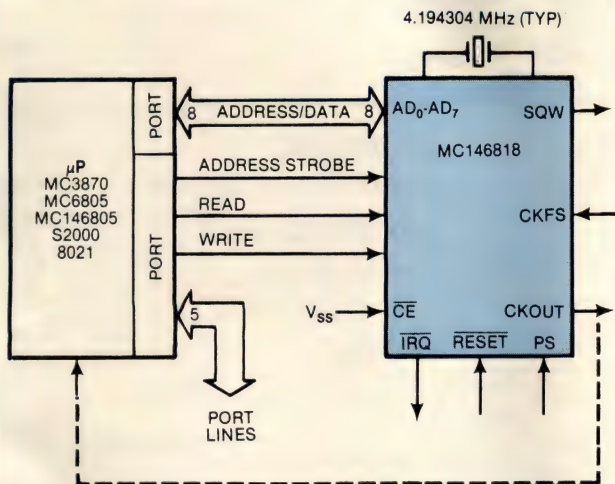


Fig 2—Interfacing clock chips with μ Cs requires few glue components or—as is evident in this hookup of Motorola's MC146818 to a microprocessor—none at all.

A typical shutdown/startup sequence for this system proceeds as follows:

- The μ P has finished a task and will be inactive for the next 6 hrs.
- The μ P loads the CDP1879 alarm registers with the desired wakeup time.
- The CDP1800's Q output is set HIGH, which stops the μ P oscillator. (Alternatively, in an NMOS system, power to all components except the clock chip could be shut off.)
- The CDP1879 receives this Q-output signal as a power-down signal.
- The CDP1879 drives all pins to a high-impedance state to accommodate powered-down chips.
- The CDP1879 eventually times out and sets an alarm by driving its INT output LOW.
- The alarm signal resets the μ P (to avoid oscillator startup problems) and flags the processor to run a warm-start routine.

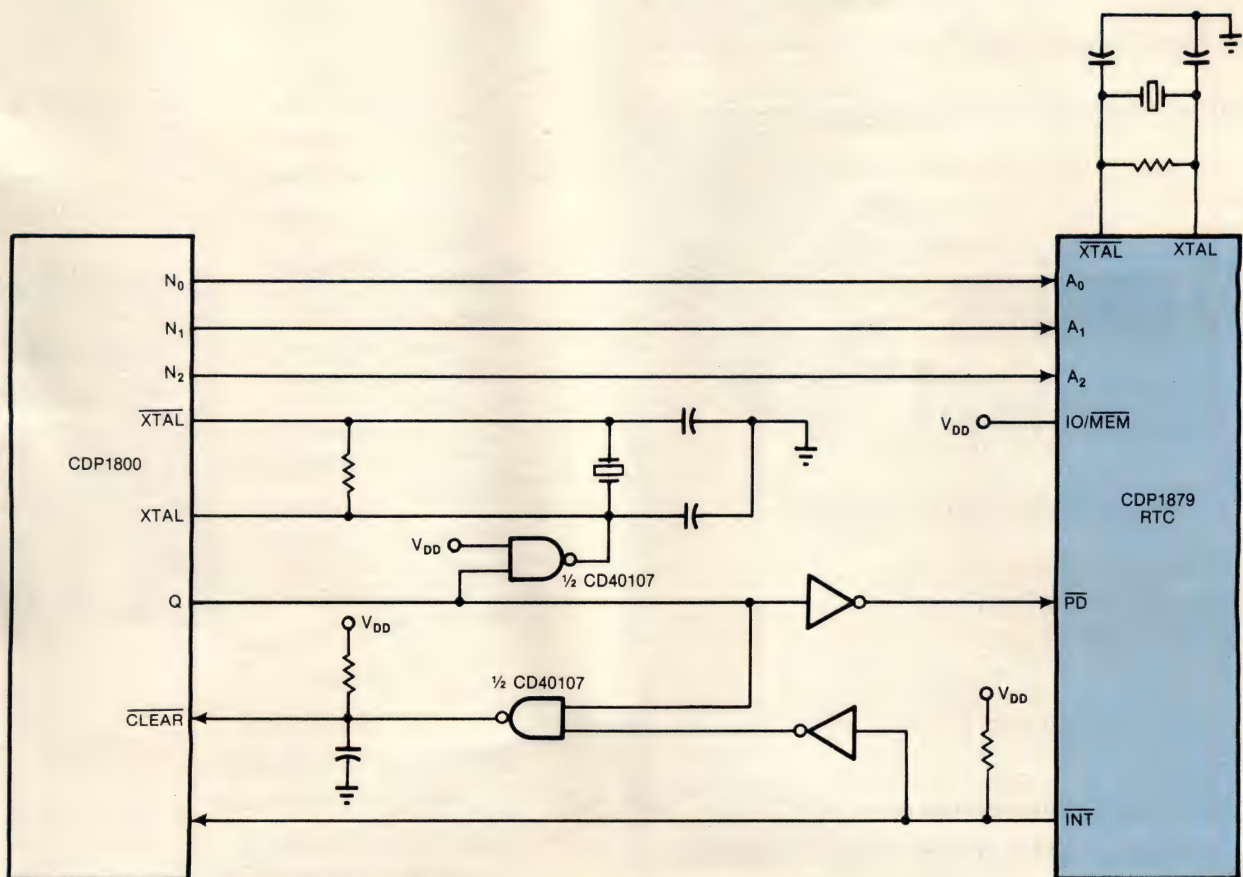


Fig 3—For applications involving intermittent μ P use, you can employ this power-down circuit based on RCA's CDP1879 real-time clock IC and thus save significant amounts of power.

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- The μ P, into its normal software sequence, writes to the CDP1879 control register to reset the interrupt request.

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**Motorola Integrated
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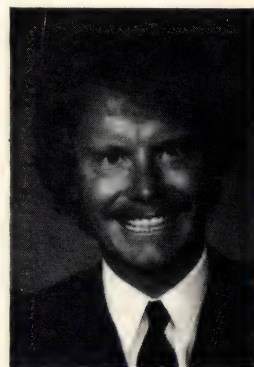
Oki Semiconductor
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Santa Clara, CA 95051
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RCA Solid State Div
Rte 202
Somerville, NJ 08876
(201) 685-6000
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Western Digital Corp
2445 McCabe Way
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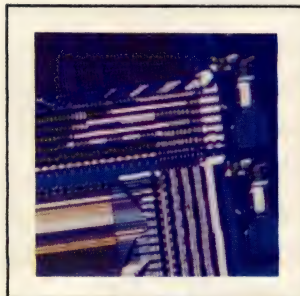
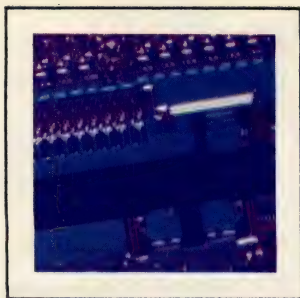
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32-bit microprocessors

Compact-code iAPX 432 addressing techniques. *Stan Mazor, Sandy Wharton, Intel Corp, Computer Design, May 1982, pg 249, 3.5 pgs.*

Examine programming objects from another viewpoint. *Jack Hemenway, Hemenway Corp, EDN, Nov 11, 1981, pg 275, 4 pgs.*

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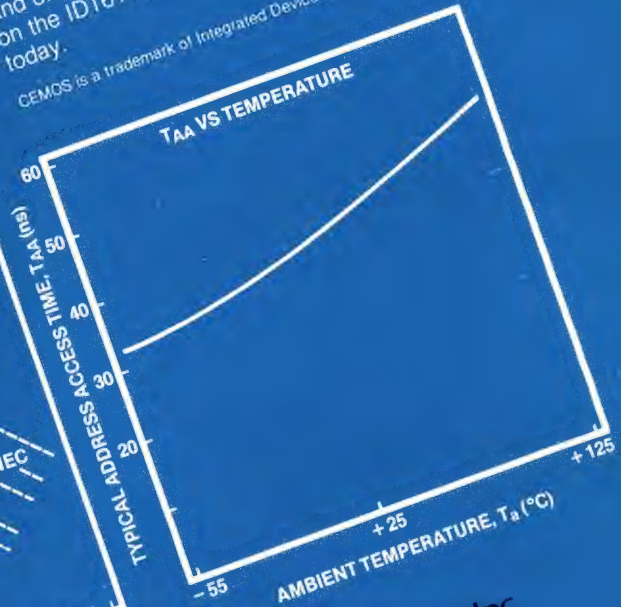
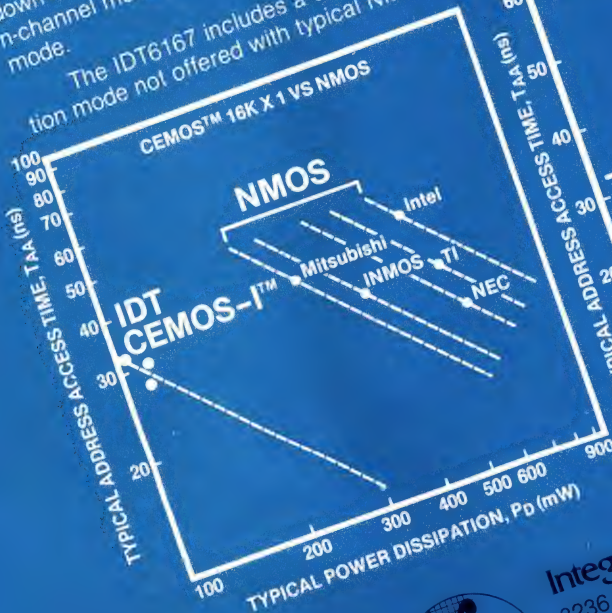
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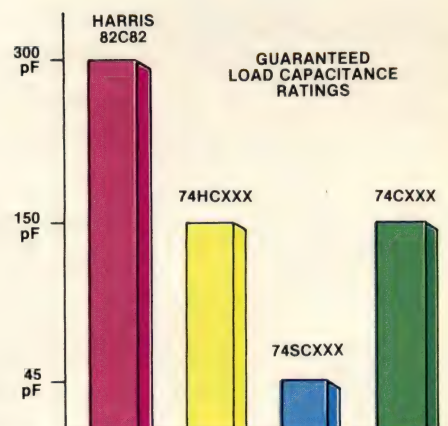
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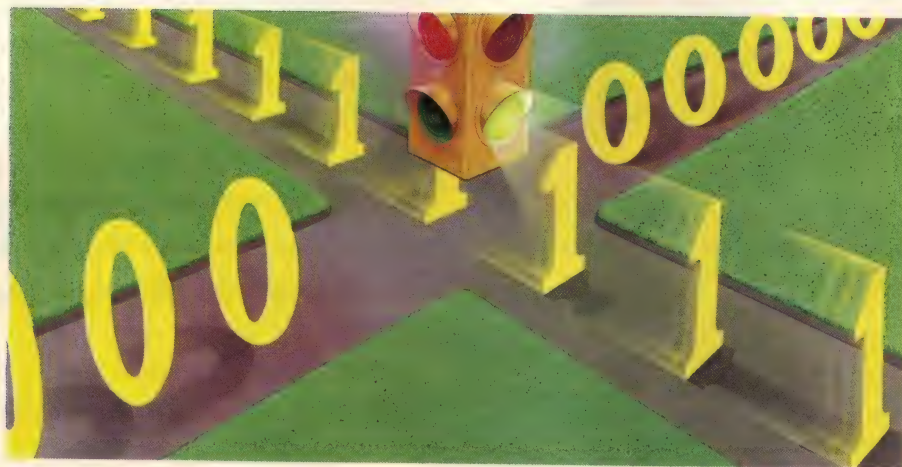


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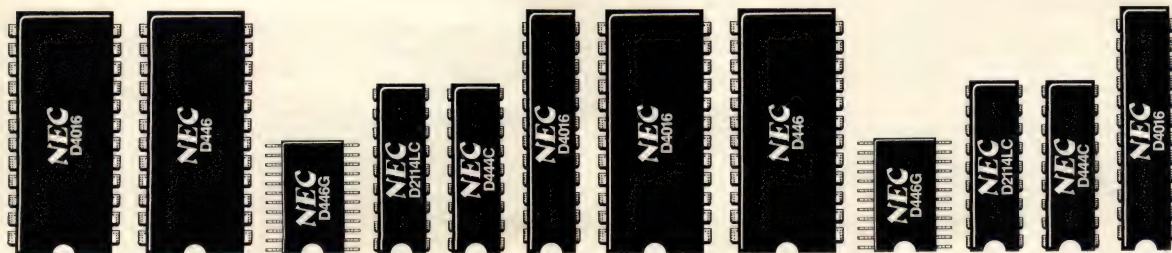
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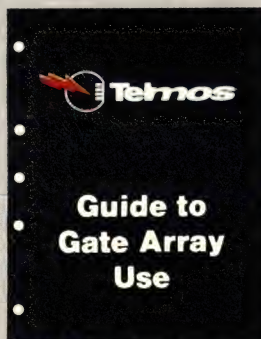
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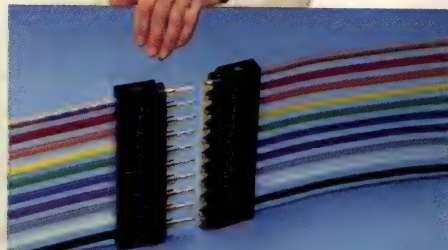
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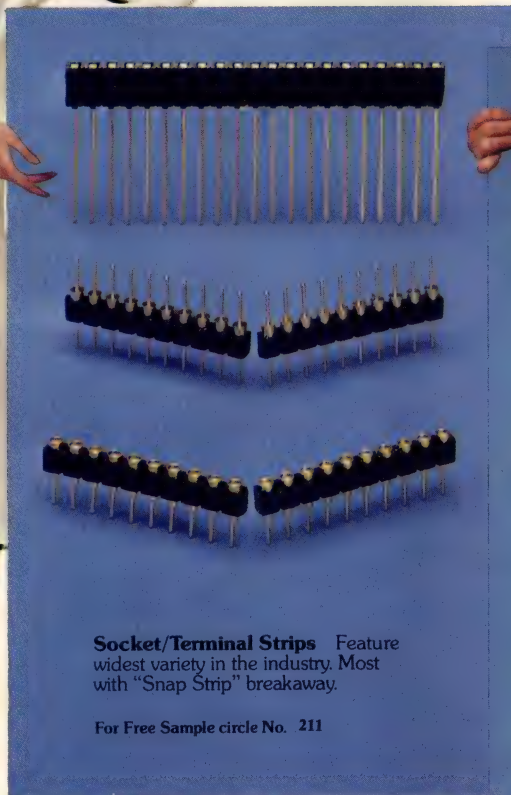
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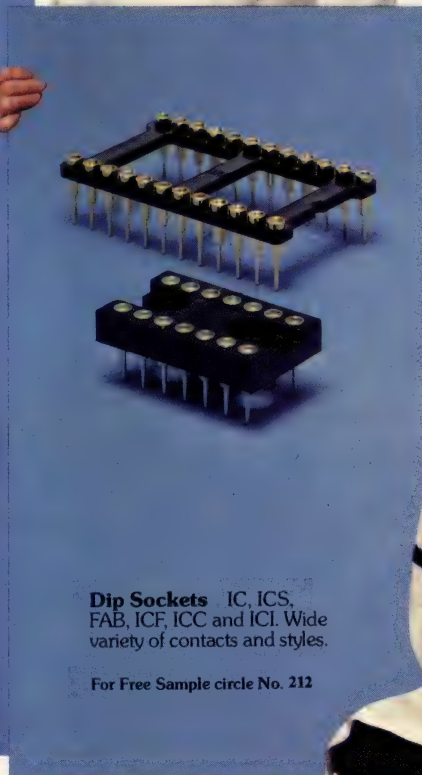
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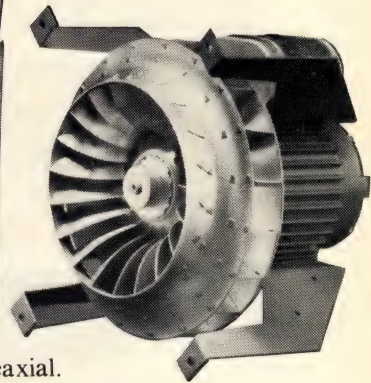
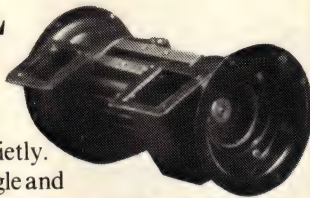


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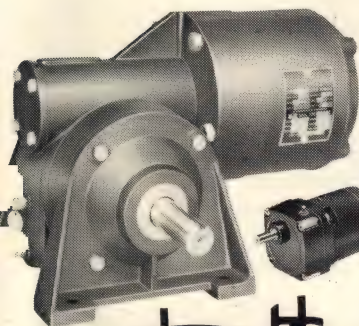
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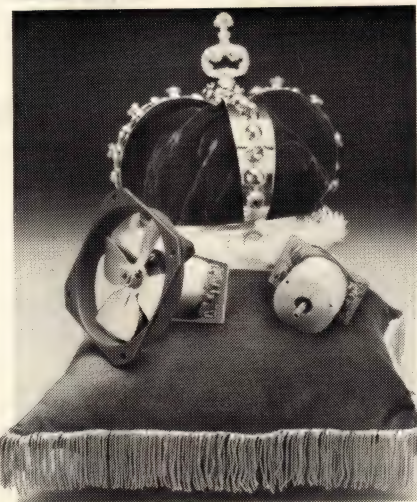
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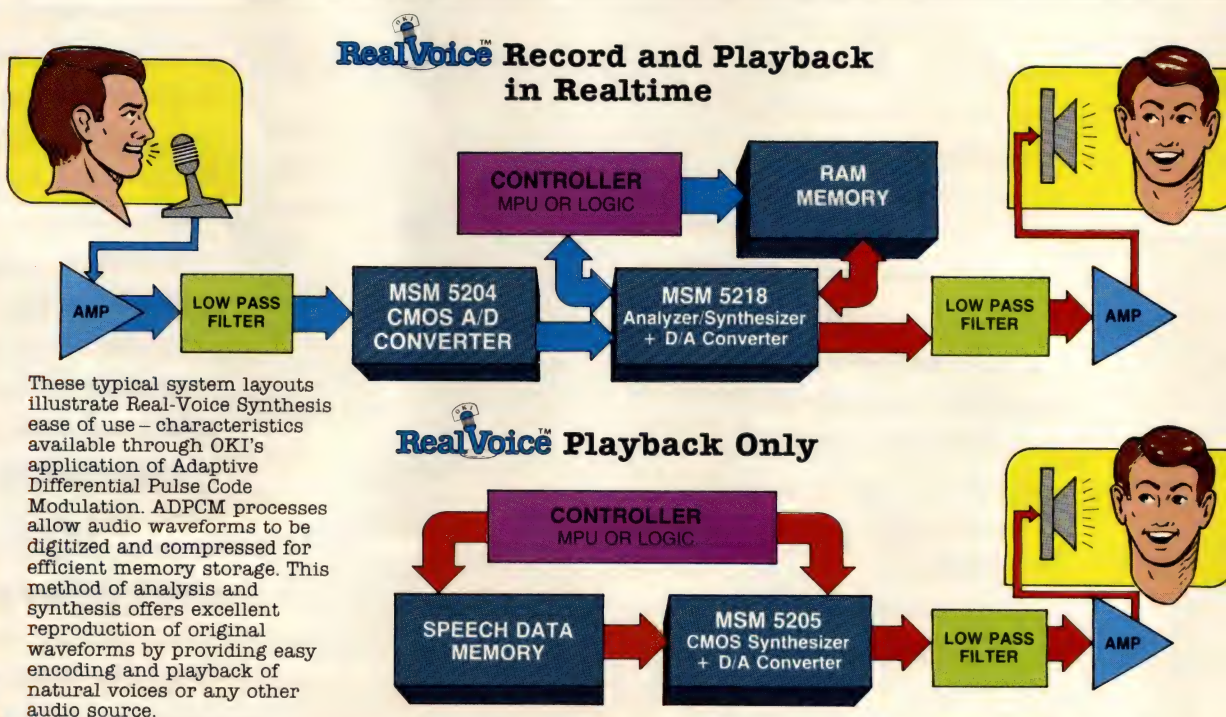
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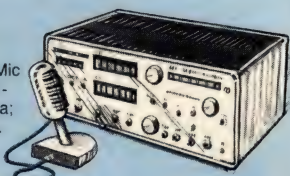
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Cartridge video games	Signal aids for blind/handicapped
Talking toys	Testing equipment
Computer directives	Teaching aids
Dial-a-Time	Temperature controllers
Tel. weather reports	Automotive advisories/signals
Tel. marine status	Security systems
Tel. directory messages	Medical diagnostic equipment
Elevators	Word processor prompting
Personal computers	Doorbells/Chimes
Tone generators	Clocks/Clock radios
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Simulation systems	CAD/CAM
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Musical instruments	Inventory monitors
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Real-Voice Record & Playback for

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Security systems	Training simulators
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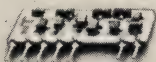
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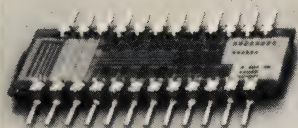
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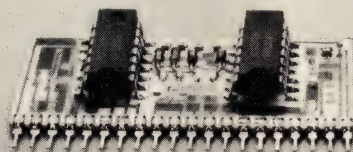
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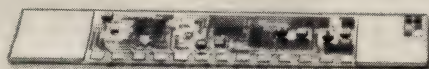
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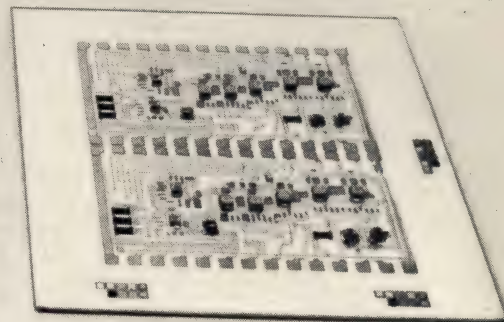
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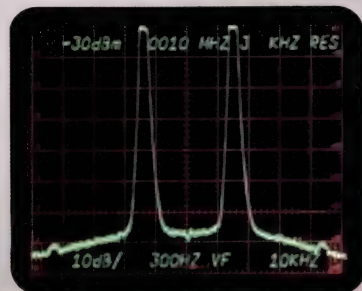
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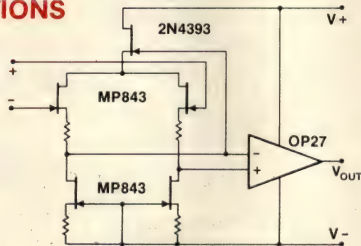
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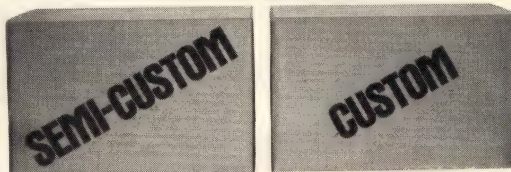
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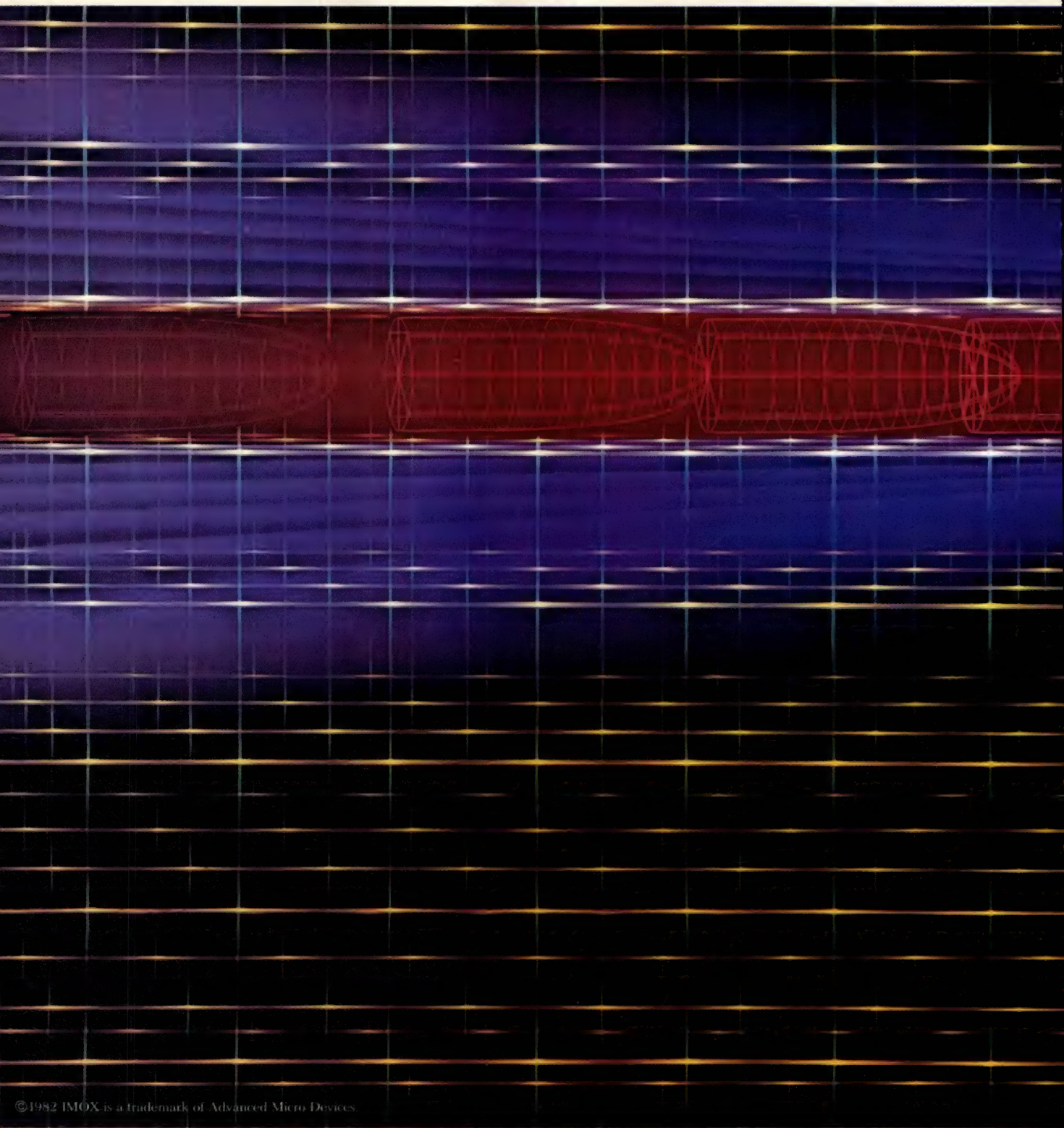
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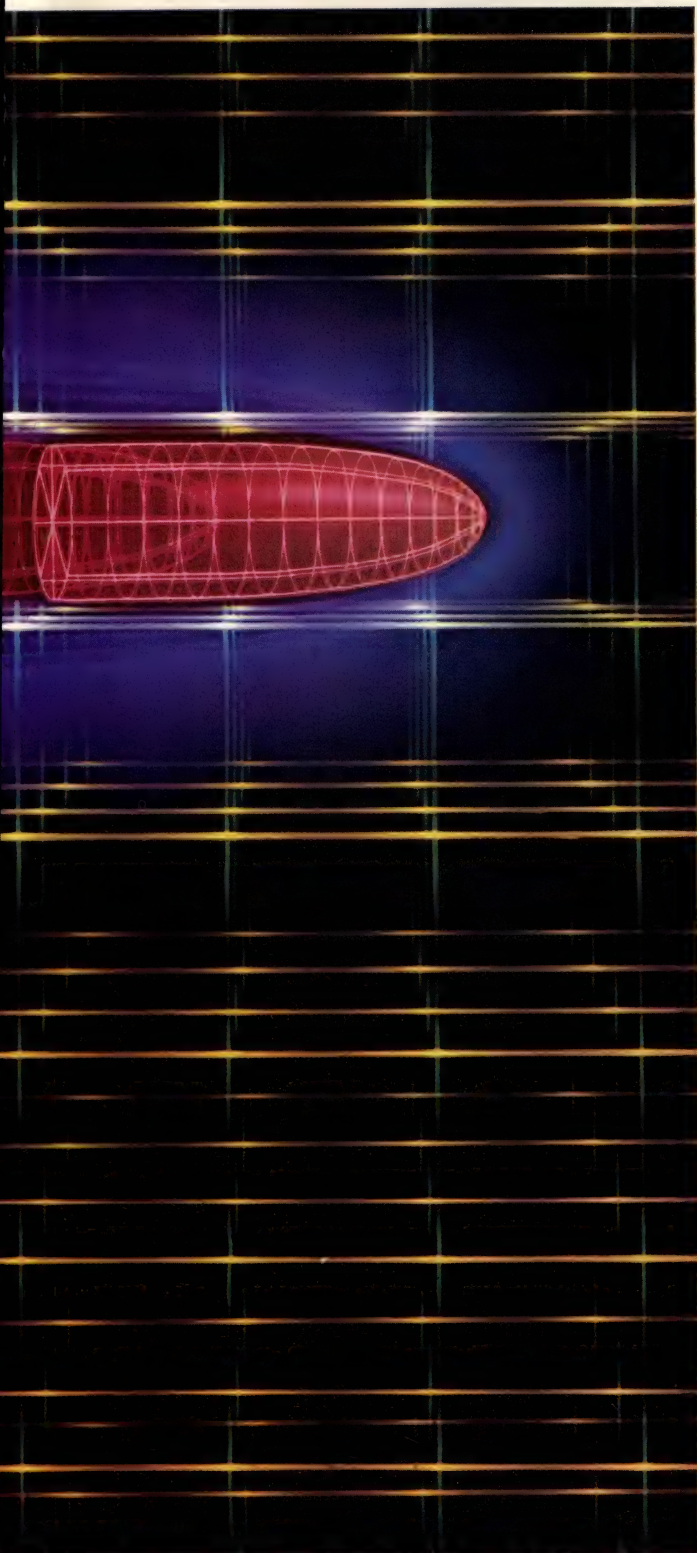
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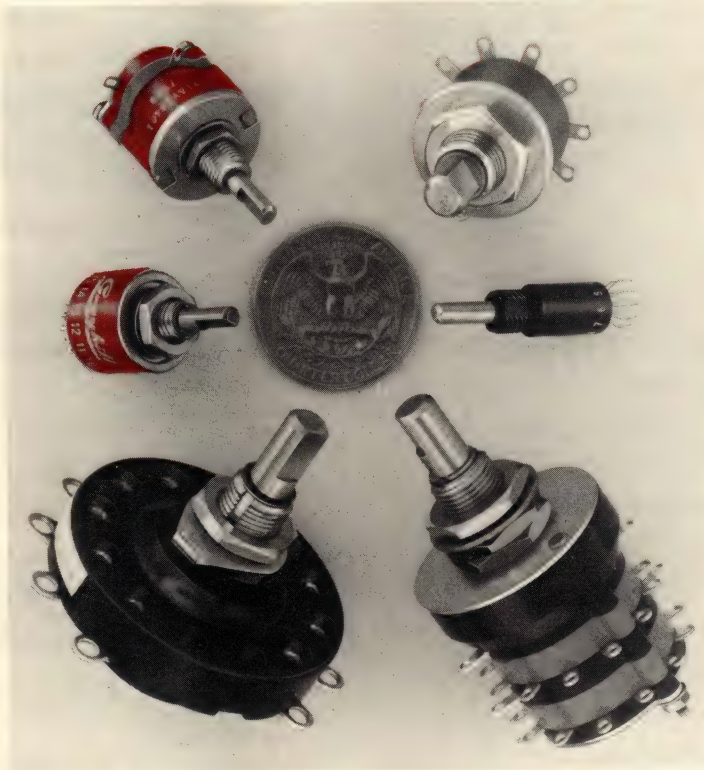
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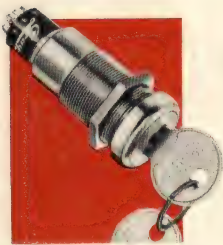
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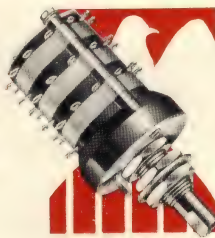
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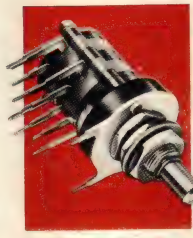
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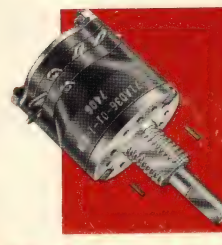
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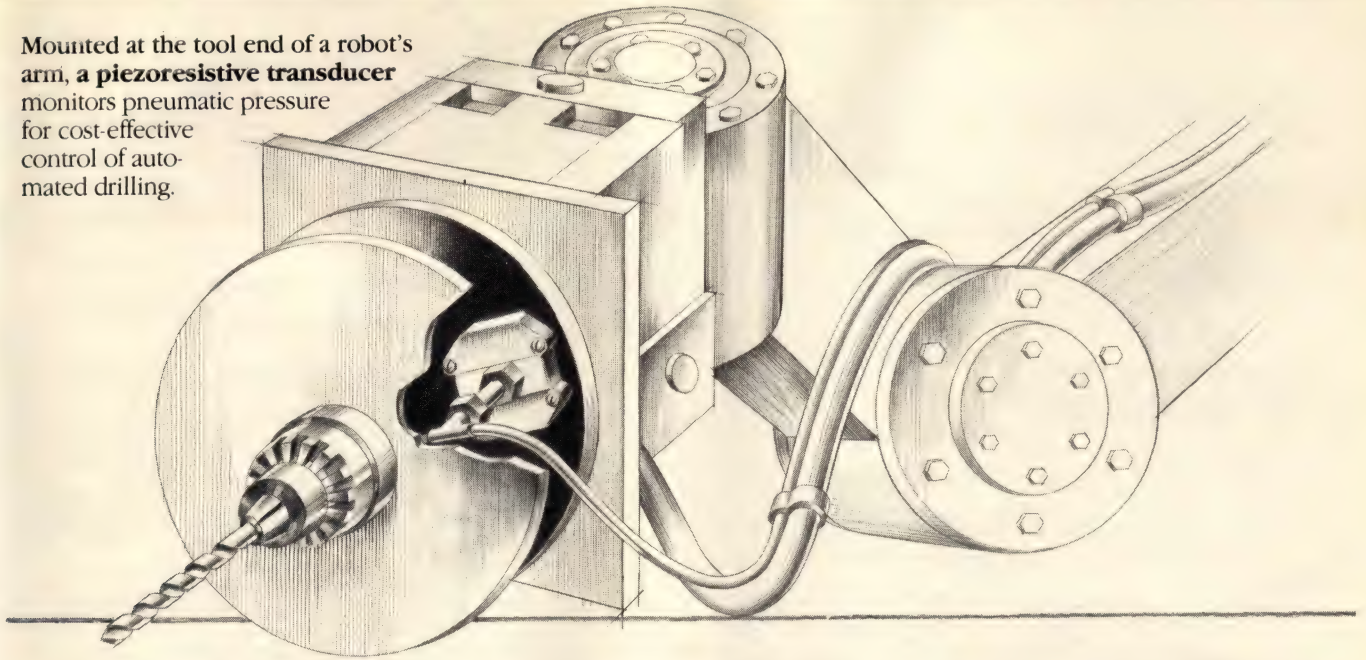


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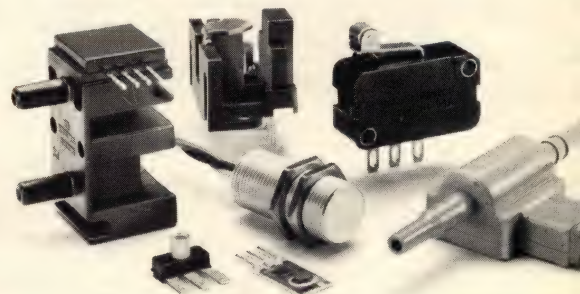
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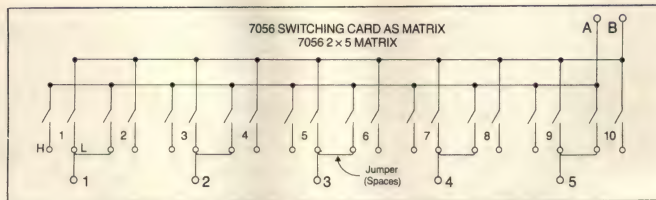
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Miniature transformers source list. *Staff written, Electronic Products, Jan 11, 1982, pg 65, 3 pgs.*

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Transformers and optocouplers implement isolation techniques. *Jim Williams, National Semiconductor Corp, EDN, Jan 6, 1982, pg 115, 6.5 pgs.*

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Duart manages a pair of programmable signal paths. *Alex Goldberger, Signetics Corp, Electronics, May 19, 1982, pg 168, 5 pgs.*

Fiber-optic transmitters accept most analog signals. *Mark Amarendos, Burr-Brown Research Corp, Electronic Design, Nov 12, 1981, pg 197, 6.5 pgs.*

High-performance hf receiver cashes in on diverse digital functions. *G Twibell, Racal Group Services Ltd, Electronics, July 14, 1982, pg 156, 3 pgs.*

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Remote-control transmitter/receiver chips exhibit enhanced capabilities. *Jim McDermott, Special Features Editor, EDN, Mar 3, 1982, pg 71, 4 pgs.*

Two-wire transmitter promotes painless process control. *Dennis R Haynes, Burr-Brown Research Corp, Electronic Design, Sept 16, 1982, pg 99, 6 pgs.*

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Open-loop controller adjusts lamps. *Richard Brush, Ampex Corp, EDN, Sept 1, 1982, pg 254, 1.33 pgs.*

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Low-cost rms/dc ICs upgrade ac measurements. *Lew Counts and Chuck Kitchin, Analog Devices Inc, and Walt Jung, Consultant, EDN, Jan 20, 1982, pg 101, 10.5 pgs.*

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M Buchanan, Beckman Instruments Inc, EDN, Jan 6 1982, pg 139, 4 pgs.



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Two-chip VCO linearly controls ramp's amplitude and frequency. *Forrest P Clay Jr, Mark S Eaton, Old Dominion Univ, Electronics, Nov 30, 1981, pg 113, 0.75 pgs.*

V-f converters demand accurate linearity testing. *Larry DeVito, Analog Devices Inc, Electronic Design, Mar 4, 1982, pg 105, 6 pgs.*

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Vertical recording brings disk drives standing-room-only densities. *RD Fisher, Jack Taranto, Applied Information Memories, Electronics, Sept 22, 1982, pg 131, 5 pgs.*

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A software interface for speech recognition. *RD Inversion, PJ Arnott, GW Pfeiffer, 3M Center, Computer Design, Mar 1982, pg 147, 4.75 pgs.*

As speech-recognition products improve, office applications appear. *Gerald Beckman, Threshold Technology Inc, Electronic Design, June 10, 1982, pg ss5, 2 pgs.*

Designers of voice-recognition systems target speaker-independent, pause-free input. *Edward Teja, Western Editor, EDN, Sept 1, 1982, pg 67, 3.67 pgs.*

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Japanese welcome voice recognition. *Robert Neff, Tokyo bureau, Electronics, Feb 10, 1982, pg 97, 2 pgs.*

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Portable speech development system creates linear predictive codes. *Gene Helms, Steve Peterson, Texas Instruments Inc, Electronics, Sept 8, 1982, pg 151, 6 pgs.*

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Speech input and output team with developments. *Roger Allen, Senior Editor, Electronic Design, May 13, 1982, pg 67, 6 pgs.*

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Turn I/O data port into speech port. *Earle West and Al Mouton, Motorola Inc, EDN, May 26, 1982, pg 212, 1 pg.*

Voice-output units show improvement in speech quality, vocabulary, price. *Edward Teja, Western Editor, EDN, May 26, 1982, pg 71, 4.33 pgs.*

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5-V converter powers EEPROMs, RS-232-C drivers. *Richard A McGrath, Studio 7 Technical Documentation, Electronics, Apr 7, 1982, pg 137, 1.33 pgs.*

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Measuring irregular waveforms by detecting amplitude changes. *Jeffrey Schenkel, Consultant, Electronics, Feb 24, 1982, pg 143, 1 pg.*

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Digital weighing scale resolves quarter counts. *David Watson, Intersil Datel UK, Electronics, June 16, 1982, pg 138, 1.25 pgs.*

Wire & cable

Flat cable & connectors Special Report. *Jim McDermott, Special Features Editor, EDN, Aug 4, 1982, pg 106, 11.5 pgs.*

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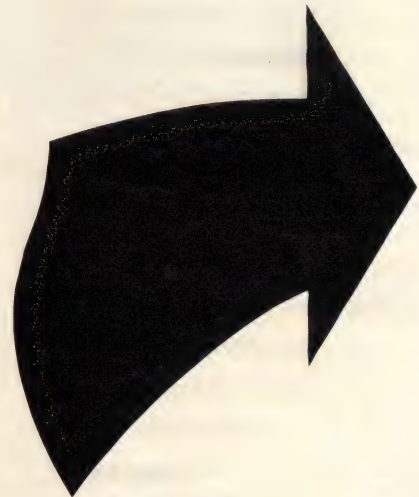
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EDN

Programmable array traps control codes

Steven Bennett

Harris Semiconductor Corp, Melbourne, FL

You can use a field-programmable logic array (FPLA) to speed ASCII-character transmissions. By trapping unnecessary control codes, the circuit simplifies the software required to process character

strings and thus lets processors operate at higher data rates. In addition, by providing a Data Valid signal that becomes active between Start of Text (STX) and End of Text (ETX) codes, the device allows multiple peripherals to share one processor-input port.

Although you can perform similar functions with 7400 Series TTL parts or PROM-based circuits, this design's FPLA implementation requires only one IC

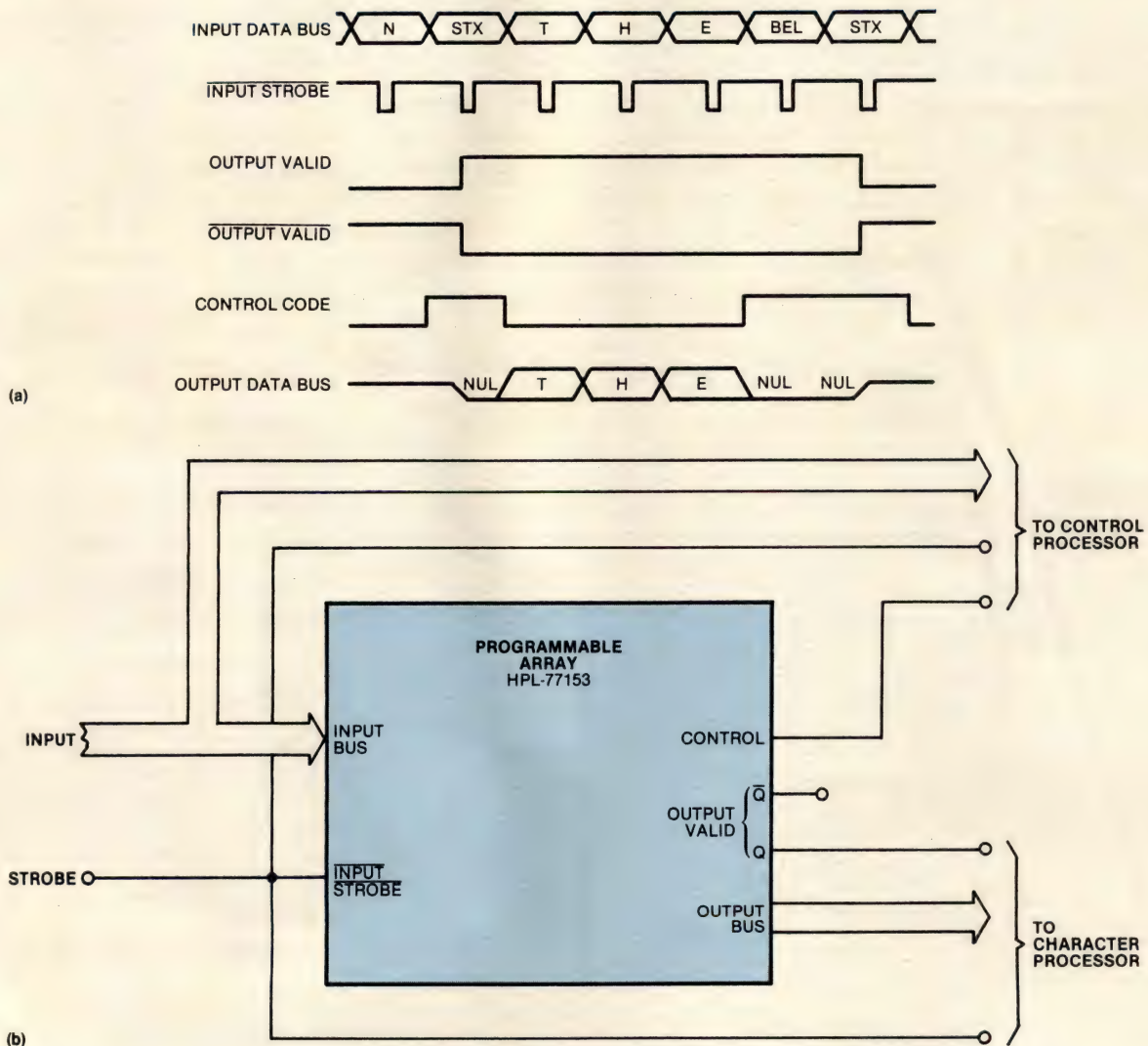


Fig 1—A control-code trap speeds ASCII-character transmissions by stripping unnecessary words from data streams. The timing diagram (a) illustrates the trap's function; the connection diagram (b) shows how you can use the circuit's control and Output Valid signals to split input data into control and character segments. The device's Output Valid signal also allows you to connect several peripherals to one processor input port.

Design Ideas

package, draws only 150 mA and operates at data rates to 10 MHz. In contrast, an SSI version requires at least one inverter for each input line, a 7-input NAND gate for each detected control code, a flip flop, and summing and 3-state output-driver logic. Similarly complex, a PROM-based implementation requires two memory arrays (one for control-code detection and one for output 3-stating) and several external logic devices and draws at least 400 mA.

Fig 1a illustrates the control-code trap's operation. The ASCII input consists of a stream of 7-bit characters and an input strobe. The strobe signal goes LOW once during each character cell to signal the presence of input data. To remove control characters from the ASCII stream, the trap circuit monitors all input codes but holds the output data bus in a high-impedance state until the input bus contains an STX character. After detecting an STX word, the trap sets an Output Valid flip flop that enables the output buffers; ETX characters reset the flip flop and restore the output bus to its 3-stated condition. The trap replaces control codes encountered during valid-output periods with null characters (null=00_H).

In addition to providing an Output Valid control signal, the trap circuit generates a control-code output that goes HIGH each time the input data

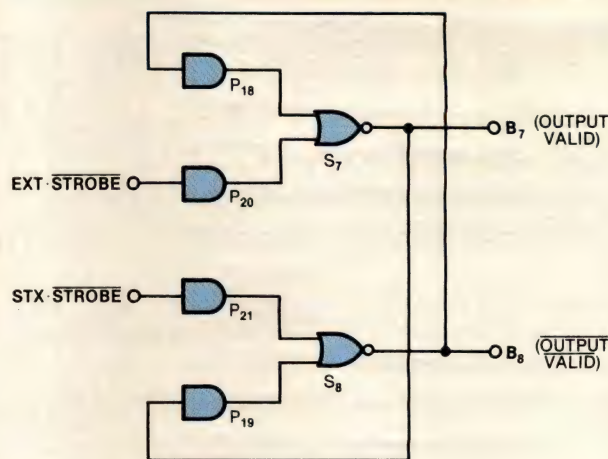


Fig 3—Two sum and four product terms combine to form an SR flip flop. Products P_{18} and P_{19} provide latch feedback, and terms P_{20} and P_{21} serve as the flip flop's inputs.

stream contains control characters. You can use that output to drive an auxiliary processor that recognizes and operates on control data (**Fig 1b**).

An HPL-77153 asynchronous FPLA (**Fig 2**) provides all of the logic needed to detect control codes and construct the Output Valid flip flop. Seven of the

Continued on pg 288

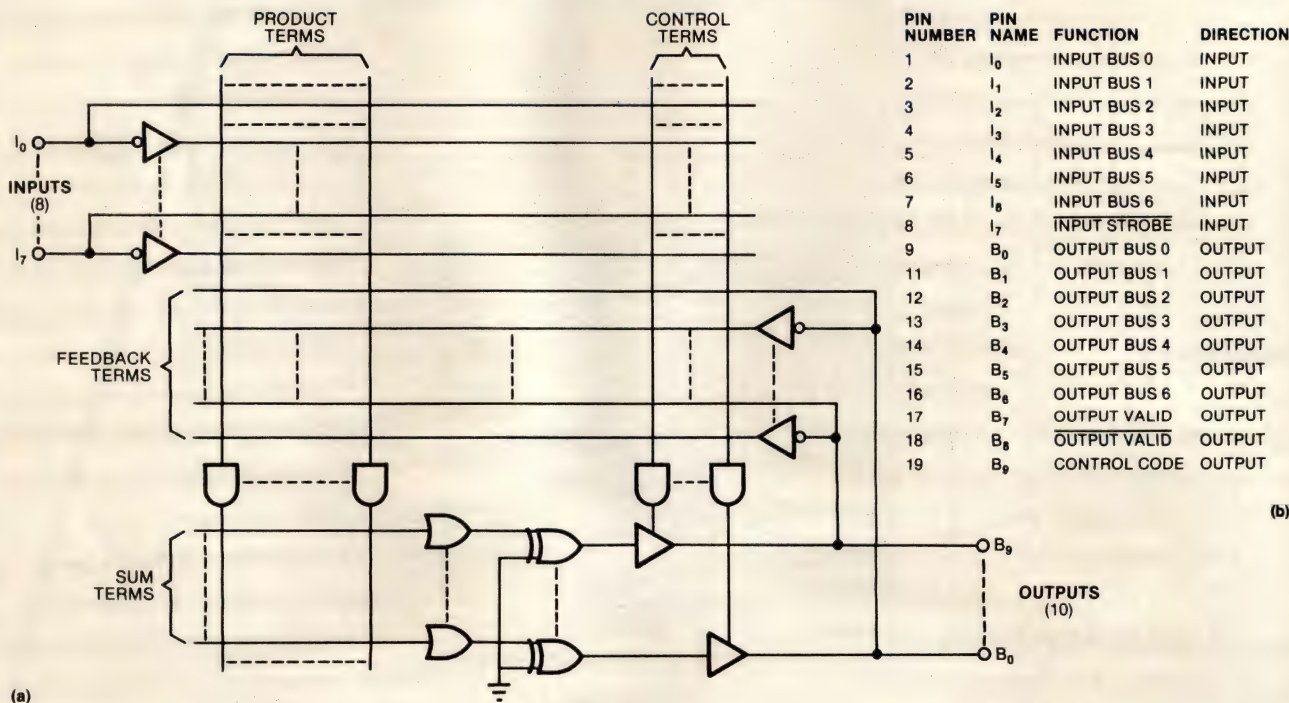
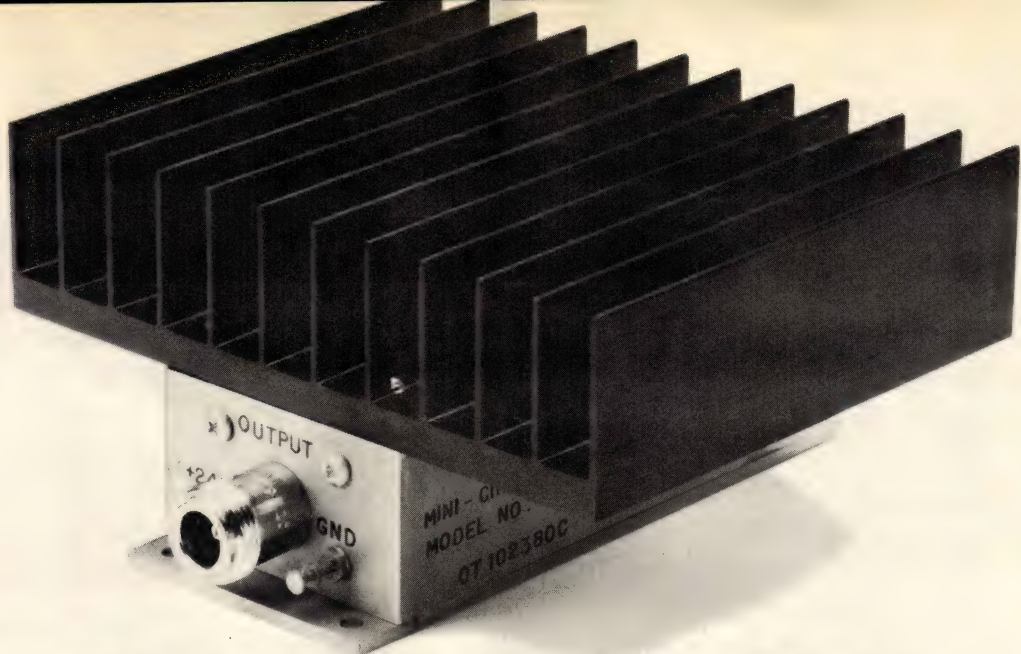


Fig 2—A field-programmable logic array (FPLA) contains all of the logic needed to implement **Fig 1**'s control-code trap. This HPL-77153 (**a**) provides product terms for code detection, sum terms for output-signal decoding and feedback terms that allow you to program an on-chip SR flip flop (**Fig 3**). The pin-assignment chart (**b**) illustrates the chip's input and output functions.



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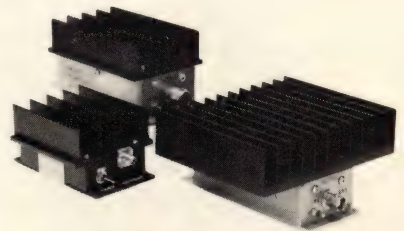


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ZHL-2-8	10-1000	27 Min.	±1.0 Max.	+29 Min.	10 Typ.	+38 Typ.	+24V	0.65A	449.00	(1-9)
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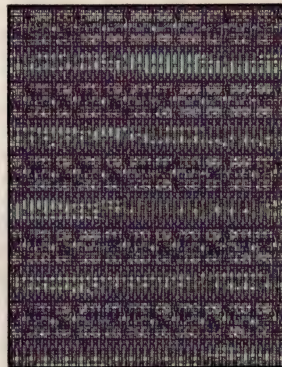
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PRODUCT TERMS	COMMENTS	SUM TERMS	COMMENTS
$P_0 = I_0 \cdot I_1 \cdot I_2 \cdot I_3 \cdot I_4 \cdot I_5$	STX	$B_0 = P_{22}$	OUTPUT ₀
$P_1 = I_0 \cdot I_1 \cdot I_2 \cdot I_3 \cdot I_4 \cdot I_5$	ETX	$B_1 = P_{23}$	OUTPUT ₁
$P_2 = I_0 \cdot I_1 \cdot I_2 \cdot I_3 \cdot I_4 \cdot I_5$	EOT	$B_2 = P_{24}$	OUTPUT ₂
$P_3 = I_0 \cdot I_1 \cdot I_2 \cdot I_3 \cdot I_4 \cdot I_5$	ENQ	$B_3 = P_{25}$	OUTPUT ₃
$P_4 = I_0 \cdot I_1 \cdot I_2 \cdot I_3 \cdot I_4 \cdot I_5$	ACK	$B_4 = P_{26}$	OUTPUT ₄
$P_5 = I_0 \cdot I_1 \cdot I_2 \cdot I_3 \cdot I_4 \cdot I_5$	BEL	$B_5 = P_{27}$	OUTPUT ₅
$P_6 = I_0 \cdot I_1 \cdot I_2 \cdot I_3 \cdot I_4 \cdot I_5$	BS	$B_6 = P_{28}$	OUTPUT ₆
$P_7 = I_0 \cdot I_1 \cdot I_2 \cdot I_3 \cdot I_4 \cdot I_5$	HT	$B_7 = \overline{P_{18}} + P_{20}$	OUTPUT VALID
$P_8 = I_0 \cdot I_1 \cdot I_2 \cdot I_3 \cdot I_4 \cdot I_5$	LF	$B_8 = \overline{P_{19}} + P_{21}$	OUTPUT VALID
$P_9 = I_0 \cdot I_1 \cdot I_2 \cdot I_3 \cdot I_4 \cdot I_5$	FF	$B_9 = P_0 + P_1 + P_2 + P_3 + P_4 + P_5 + P_6 + P_7 + P_8 + P_9$	CONTROL CODE
$P_{10} = I_0 \cdot I_1 \cdot I_2 \cdot I_3 \cdot I_4 \cdot I_5$	CR	$+ P_{10} + P_{11} + P_{12} + P_{13} + P_{14} + P_{15} + P_{16} + P_{17}$	
$P_{11} = I_0 \cdot I_1 \cdot I_2 \cdot I_3 \cdot I_4 \cdot I_5$	DLE	CONTROL TERMS	
$P_{12} = I_0 \cdot I_1 \cdot I_2 \cdot I_3 \cdot I_4 \cdot I_5$	DC ₁	$D_0 = B_7$	B ₀ 3-STATE
$P_{13} = I_0 \cdot I_1 \cdot I_2 \cdot I_3 \cdot I_4 \cdot I_5$	DC ₂	$D_1 = B_7$	B ₁ 3-STATE
$P_{14} = I_0 \cdot I_1 \cdot I_2 \cdot I_3 \cdot I_4 \cdot I_5$	DC ₃	$D_2 = B_7$	B ₂ 3-STATE
$P_{15} = I_0 \cdot I_1 \cdot I_2 \cdot I_3 \cdot I_4 \cdot I_5$	DC ₄	$D_3 = B_7$	B ₃ 3-STATE
$P_{16} = I_0 \cdot I_1 \cdot I_2 \cdot I_3 \cdot I_4 \cdot I_5$	NAK	$D_4 = B_7$	B ₄ 3-STATE
$P_{17} = I_0 \cdot I_1 \cdot I_2 \cdot I_3 \cdot I_4 \cdot I_5$	ESC	$D_5 = B_7$	B ₅ 3-STATE
$P_{18} = B_9$	FLIP-FLOP FEEDBACK	$D_6 = B_7$	B ₆ 3-STATE
$P_{19} = B_7$	FLIP-FLOP FEEDBACK	$D_7 = 1$	UNCONDITIONALLY ACTIVE
$P_{20} = I_0 \cdot I_1 \cdot I_2 \cdot I_3 \cdot I_4 \cdot I_5 \cdot I_7$	STX STROBE	$D_8 = 1$	UNCONDITIONALLY ACTIVE
$P_{21} = I_0 \cdot I_1 \cdot I_2 \cdot I_3 \cdot I_4 \cdot I_5 \cdot I_7$	ETX STROBE	$D_9 = 1$	UNCONDITIONALLY ACTIVE
$P_{22} = I_0 \cdot B_9$	INPUT ₀ CONTROL CODE	EXCLUSIVE-OR FUSES	
$P_{23} = I_1 \cdot B_9$	INPUT ₁ CONTROL CODE	$B_0 = \text{INTACT}$	NONINVERTING
$P_{24} = I_2 \cdot B_9$	INPUT ₂ CONTROL CODE	$B_1 = \text{INTACT}$	NONINVERTING
$P_{25} = I_3 \cdot B_9$	INPUT ₃ CONTROL CODE	$B_2 = \text{INTACT}$	NONINVERTING
$P_{26} = I_4 \cdot B_9$	INPUT ₄ CONTROL CODE	$B_3 = \text{INTACT}$	NONINVERTING
$P_{27} = I_5 \cdot B_9$	INPUT ₅ CONTROL CODE	$B_4 = \text{INTACT}$	NONINVERTING
$P_{28} = I_6 \cdot B_9$	INPUT ₆ CONTROL CODE	$B_5 = \text{INTACT}$	NONINVERTING
$P_{29} = \text{NOT USED}$		$B_6 = \text{INTACT}$	NONINVERTING
$P_{30} = \text{NOT USED}$		$B_7 = \text{PROGRAMMED}$	INVERTING
$P_{31} = \text{NOT USED}$		$B_8 = \text{PROGRAMMED}$	INVERTING
		$B_9 = \text{INTACT}$	NONINVERTING

Fig 4—Boolean expressions define the FPLA's fuse patterns. Product terms P_0 through P_{17} decode 18 control characters; you can reassign the terms to detect a different set of codes, or you can program unused terms P_{29} , P_{30} and P_{31} to decode additional characters. Control-code output B_9 goes HIGH if any of the 18 control products goes HIGH.

chip's eight input lines (I_0 through I_6) connect to the input data bus, and the array's product terms allow direct detection of control codes; each of 18 product AND gates connects to a combination of inverted and noninverted input signals and thus decodes a specific data word. The array's programmable OR plane provides sum terms, generating sum-of-products output signals; 10 control terms and 10 XOR gates control output enabling and signal polarity, respectively.

The HPL-77153's internal feedback terms allow you to construct an SR flip flop (**Fig 3**) that generates latching Output Valid and Output Valid signals. Two of the IC's sum terms (S_7 and S_8), programmed for inverted polarity, connect to four product buses: Product terms P_{18} and P_{19} provide latch feedback, and signals P_{20} and P_{21} serve as the flip flop's inputs. P_{21} goes HIGH when an STX character coincides with a LOW level on the input strobe (I_7), and P_{20} goes HIGH during ETX character cells. Note that the flip flop's feedback requires signals to pass through the gate array twice. You must remain certain, therefore, that the input strobe remains LOW for at least

two array-propagation-delay intervals. (The HPL-77153's propagation delay equals 40 nsec typ.)

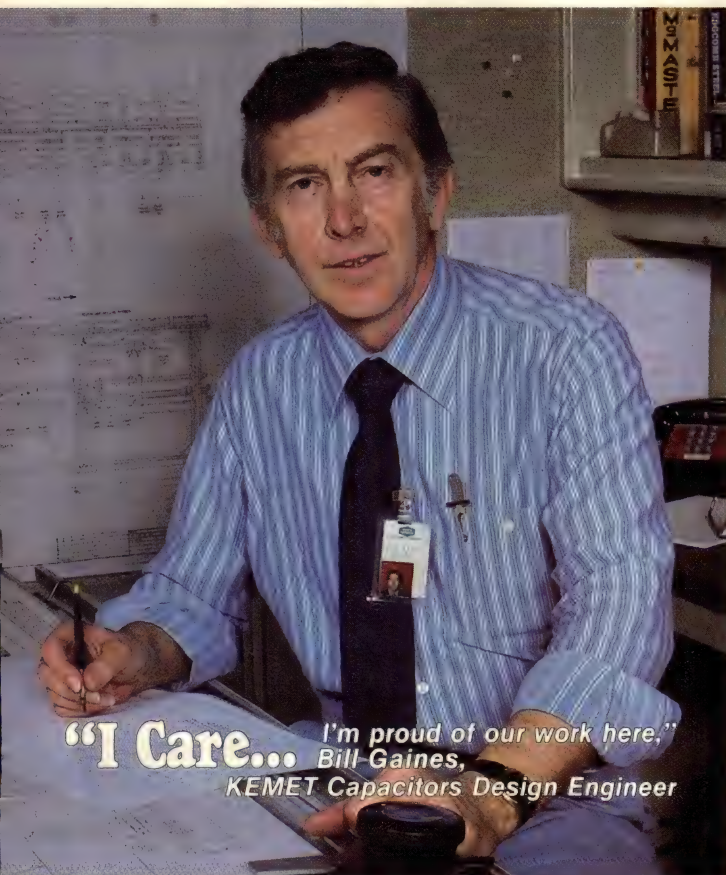
Fig 4 illustrates the programming equations for the entire array. Product terms P_0 through P_{17} decode 18 common control codes by evaluating each of the seven input lines. Terms P_{18} , P_{19} , P_{20} and P_{21} form the flip flop's feedback and input signals; P_{22} through P_{28} provide the data signals while the control-code output (B_9) remains LOW and force null characters when output B_9 goes HIGH.

To complete the array's configuration, sum terms B_0 through B_7 form the circuit's output bus by connecting to product terms P_{22} through P_{28} , and B_9 drives the control-code output HIGH if any of the 18 control-code products goes HIGH. Output Valid line B_7 enables the output bus through control lines D_0 through D_6 ; terms D_7 , D_8 and D_9 force the Output Valid and control codes into unconditionally active states.

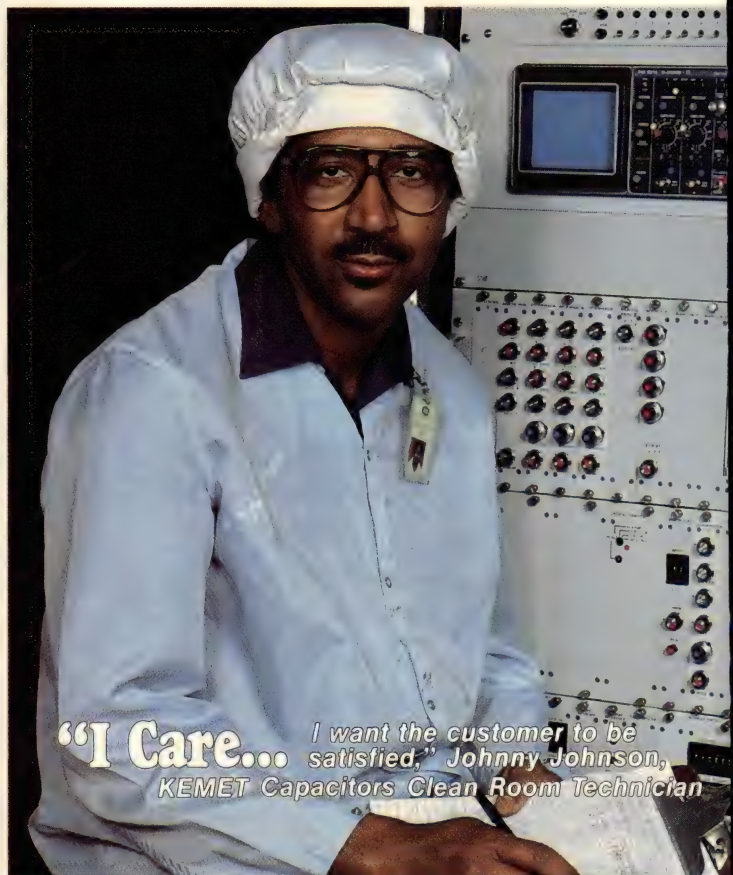
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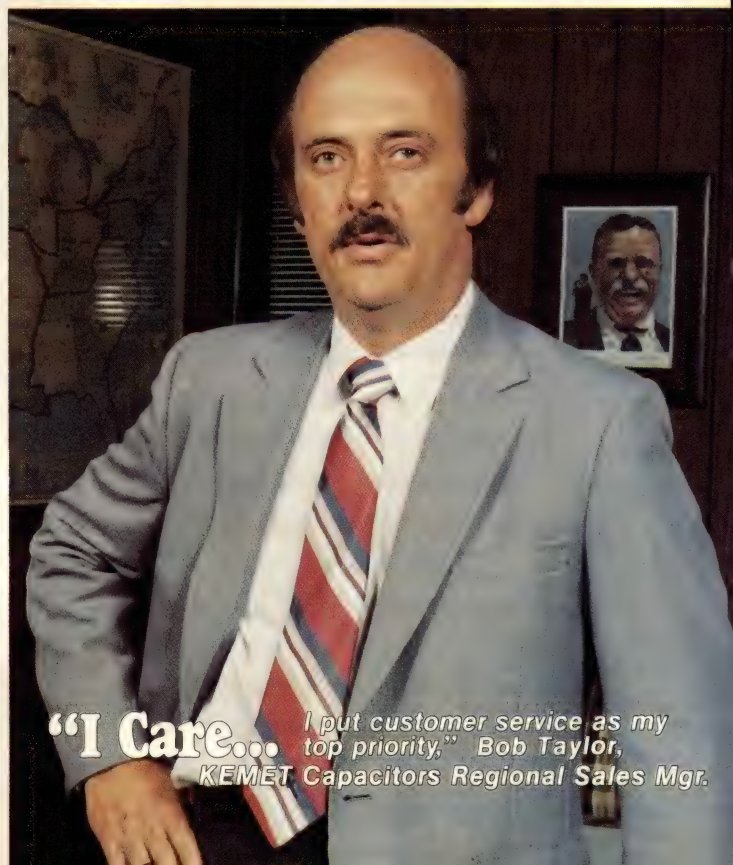
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Bill Gaines,
KEMET Capacitors Design Engineer



"I Care... I want the customer to be
satisfied," Johnny Johnson,
KEMET Capacitors Clean Room Technician



"I Care... I work hard to get the job
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Remote controller needs only two ICs

William Pierce
Motorola Inc, Phoenix, AZ

By employing an infrared transmitter/receiver IC pair and a simple interrupt-service routine, you can add remote control to μ P-based systems. The

remote-control circuit uses a low-duty-cycle AM data format that results in minimal transmitter power requirements, and the system's few components add only \$3 to a product's semiconductor costs.

The remote-control transmitter (**Fig 1a**) consists of an MC14497P transmitter IC, a matrix keypad and an IR emitter. The transmitter chip scans the keyboard and generates a biphaser serial output

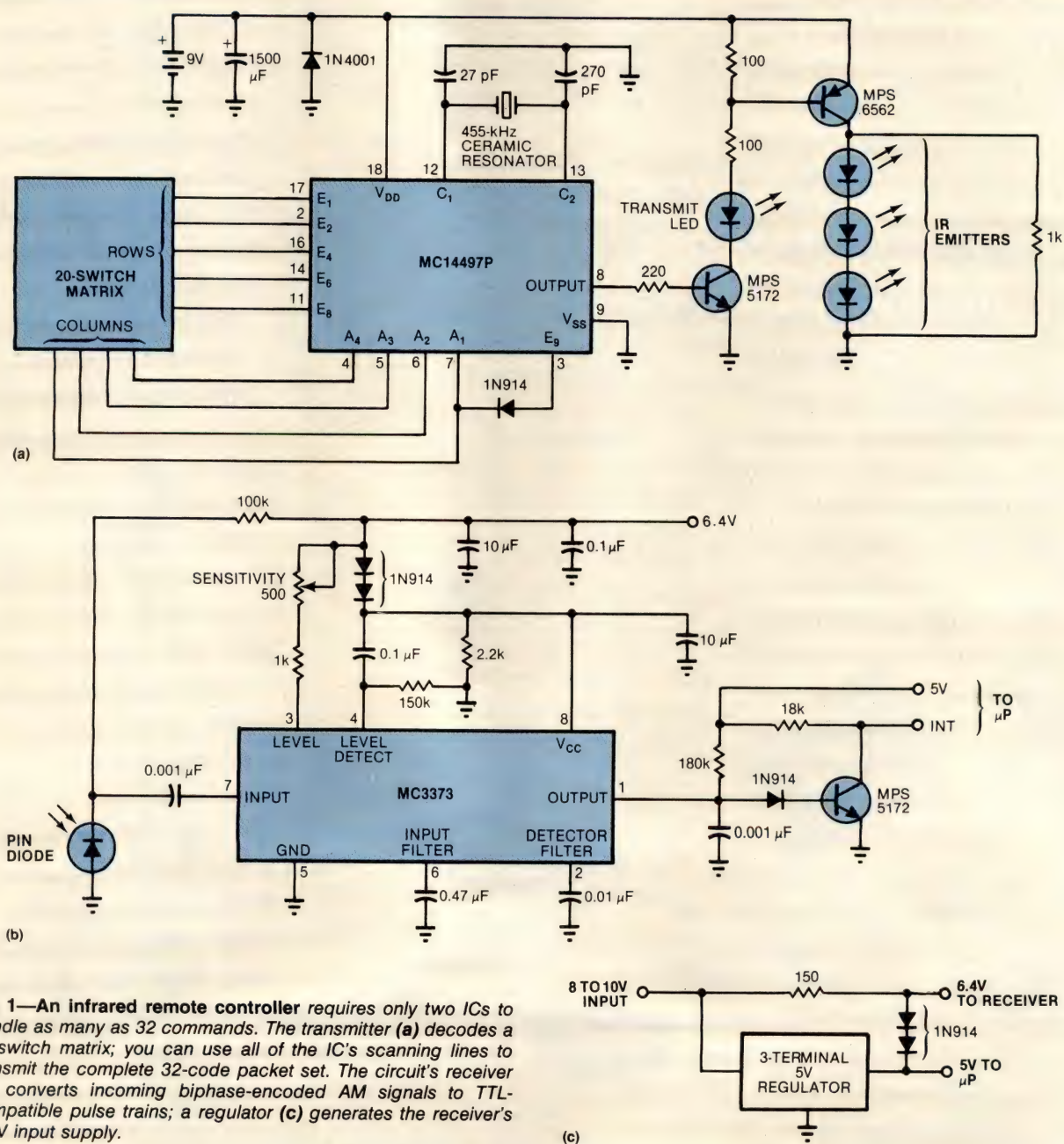


Fig 1—An infrared remote controller requires only two ICs to handle as many as 32 commands. The transmitter (a) decodes a 20-switch matrix; you can use all of the IC's scanning lines to transmit the complete 32-code packet set. The circuit's receiver (b) converts incoming biphaser-encoded AM signals to TTL-compatible pulse trains; a regulator (c) generates the receiver's 6.4V input supply.

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CIRCLE NO 98

Design Ideas

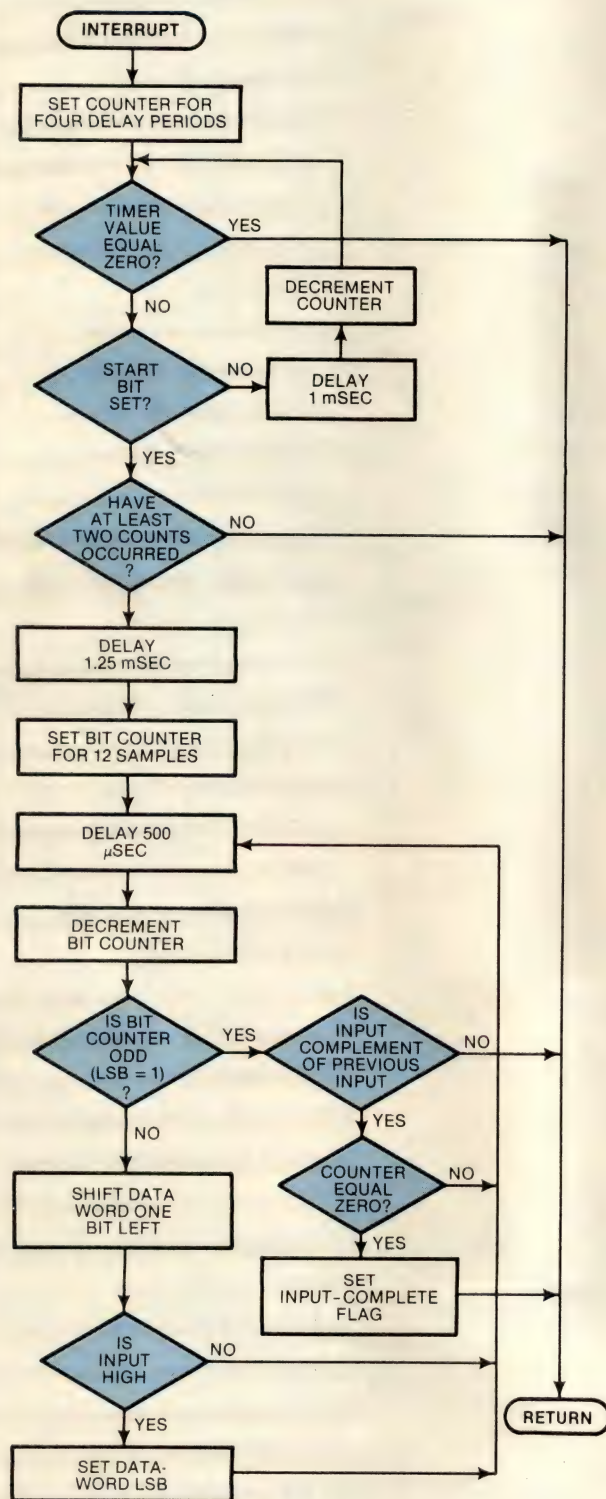


Fig 2—An interrupt-service routine decodes input data streams. The program rejects invalid data by measuring the 2- to 4-msec delay between power-on and start bits and by ensuring that each 1-msec data cell contains a level transition.

stream each time a key gets depressed. A 455-kHz ceramic resonator drives the transmitter's clock, and an internal counter chain divides the signal to produce a 40-kHz output carrier.

The transmitter's 9-msec data packet includes a power-on bit, a start bit and six data bits that allow as many as 32 distinct output codes. To allow receiver AGCs to settle after detecting incoming data, the transmitter inserts a 2-msec delay between the power-on and start bits. So long as a key remains depressed, the transmitter repeats the data packet at a 110-Hz rate, thereby simplifying the software required to implement continuous functions such as increasing or decreasing volume or stepping through a command sequence. After a key is released, the transmitter sends an end-of-transmission packet.

The system's receiver (**Fig 1b**) derives its function from an MC3373 demodulator IC. The chip includes a high-gain amplifier that boosts a PIN diode's output signal by as much as 90 dB, and an internal AGC maintains a constant signal level regardless of input intensity. The receiver IC also includes an envelope detector that converts the incoming AM signal to an output pulse train. The MC3373's inherent bandpass response eliminates the need for tuned filters; you should, however, ensure that the receiver remains well grounded and shielded to avoid noise pickup.

You can generate the MC3373's 6.4V min power-supply level from the same supply that powers your system's μ P. Most μ P circuits employ a 3-terminal 5V regulator fed by an 8 to 10V input, and a simple shunt regulator (**Fig 1c**) uses the 5V supply as a reference for generating the receiver's 6.4V input.

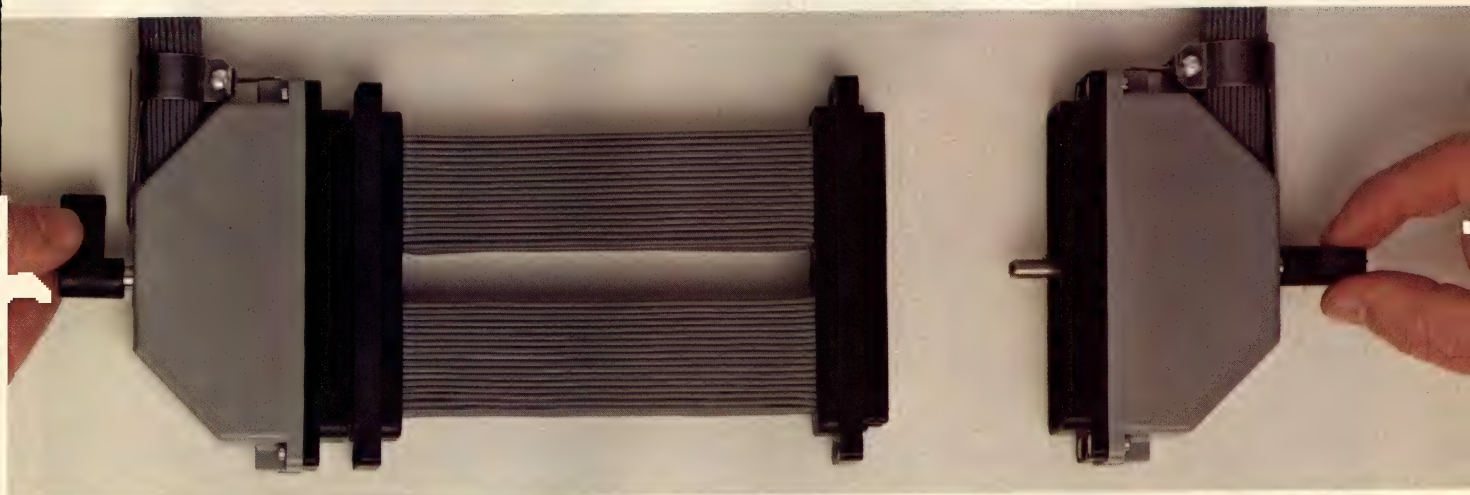
To decode incoming pulse trains, the remote control's receiver program must monitor clock transitions and use transmitted data to direct branches to appropriate control routines. A typical interrupt-service program (**Fig 2**) loads data into a register that the host μ P's operating system can use as an addressing index for table-driven command execution; the data value serves as an offset for look-up operations.

Upon receiving a power-on bit, **Fig 2's** program enters a timeout loop that checks for a start bit within a 2- to 4-msec window. Valid start bits trigger a data-recovery loop that records the input signal's status at 500- μ sec intervals. The routine expects one input transition within each 1-msec data cell and aborts the decoding process if transitions occur more than 1 msec apart.

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A new twist on the old push and pull.

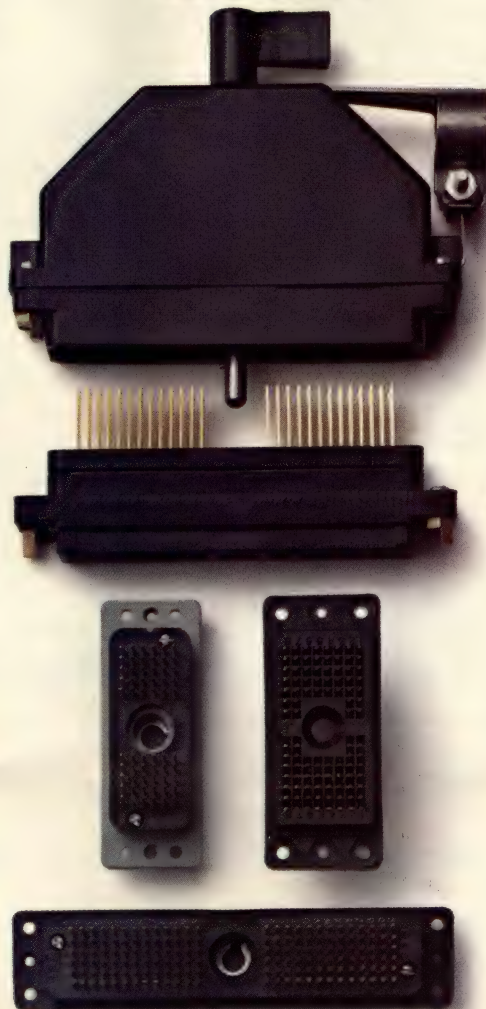


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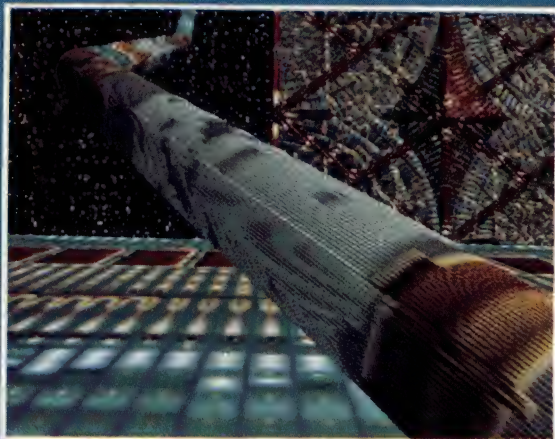
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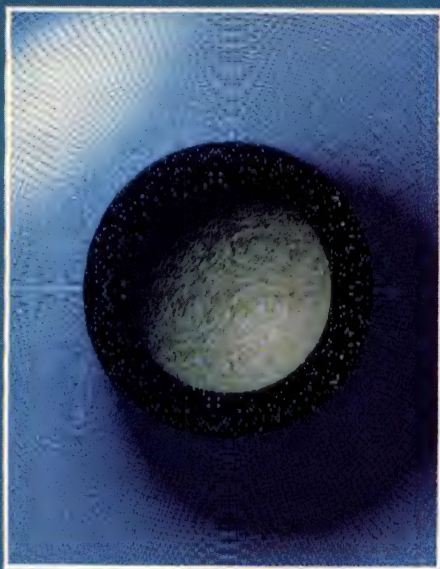
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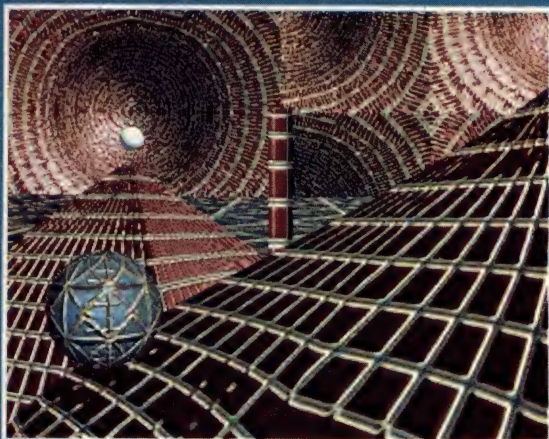


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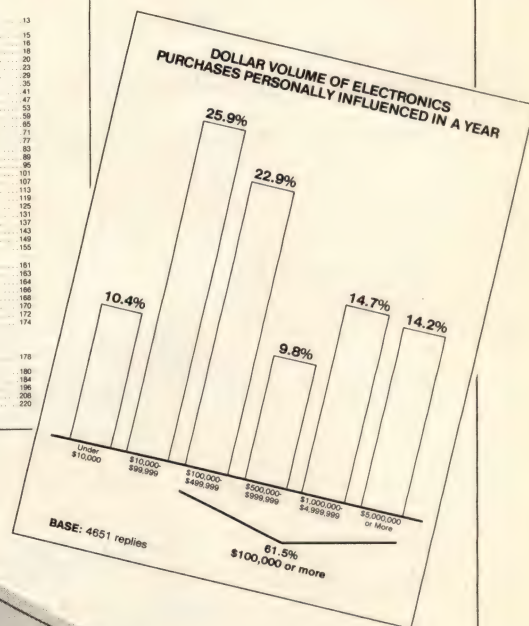
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Counters generate period's square root

Marian Stofka
Bratislava, Czechoslovakia

Measurement and control systems occasionally process algorithms that include terms proportional to a time interval's square root, $\sqrt{t}$. Typically, designers generate $\sqrt{t}$ values either by employing an analog integrator and divider or by programming a counter-driven PROM with the appropriate data. But both methods entail severe accuracy and resolution limitations. A better $\sqrt{t}$ -generation scheme (**Fig 1**) employs an implicit digital square-rooting technique and provides accuracy that's limited only by the number of counters in the circuit's dividing chain.

To understand the circuit's operation, consider that the output counter acts as an integrator. Thus, the square rooter's output equals

$$X = \int_0^t F_D dt, \quad (1)$$

where F_D is the variable-modulo divider's output

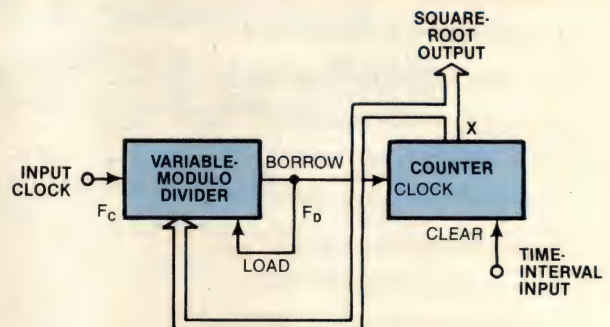


Fig 1—A digital square-root generator implicitly derives codes proportional to the square root of an input pulse's duration. An output counter accumulates Borrow pulses generated by a variable-modulo divider fed by an input clock and the circuit's square-root output. A HIGH level at the time-interval input starts the circuit by resetting the output counter.

frequency. But because the divider's programming inputs connect to the square-root output X , F_D equals

$$F_D = \frac{F_C}{X}, \quad (2)$$

Continued on pg 307

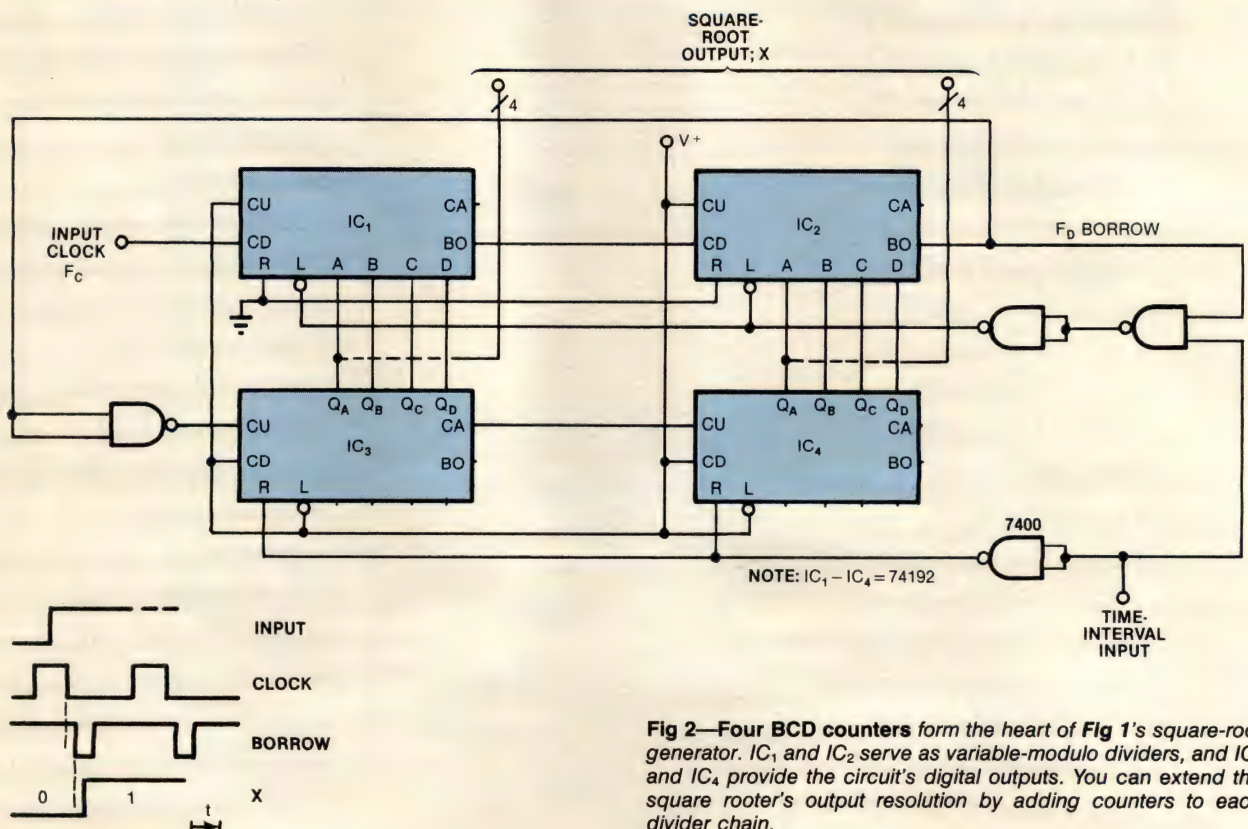


Fig 2—Four BCD counters form the heart of Fig 1's square-root generator. IC₁ and IC₂ serve as variable-modulo dividers, and IC₃ and IC₄ provide the circuit's digital outputs. You can extend the square rooter's output resolution by adding counters to each divider chain.

The RCA 1800 series:

The world's broadest, most powerful
line of 8-bit CMOS μ Ps/ μ C.



Our full line of powerful 8-bit CMOS micros is spearheaded by the new 1804A.

We invented CMOS. And we introduced the industry's first CMOS microprocessor in 1976.

Since then, the RCA 1800 series has been continually expanded to meet our customers' needs, and to provide ever-greater performance characteristics.

Today, there is a wide range of devices in the RCA 1800 series. This brochure will give you an overview of the capabilities of our versatile and very low power CMOS 8-bit family.

A powerful new micro-computer.

The new RCA 1804A CMOS μ C comprises a CPU, 2K bytes of mask-programmable ROM, 64 bytes of RAM and 8-bit timer/counter that operates in six different modes.

It's the world's first 100% static CMOS 8-bit microcomputer with addressing capability up to 64K bytes.

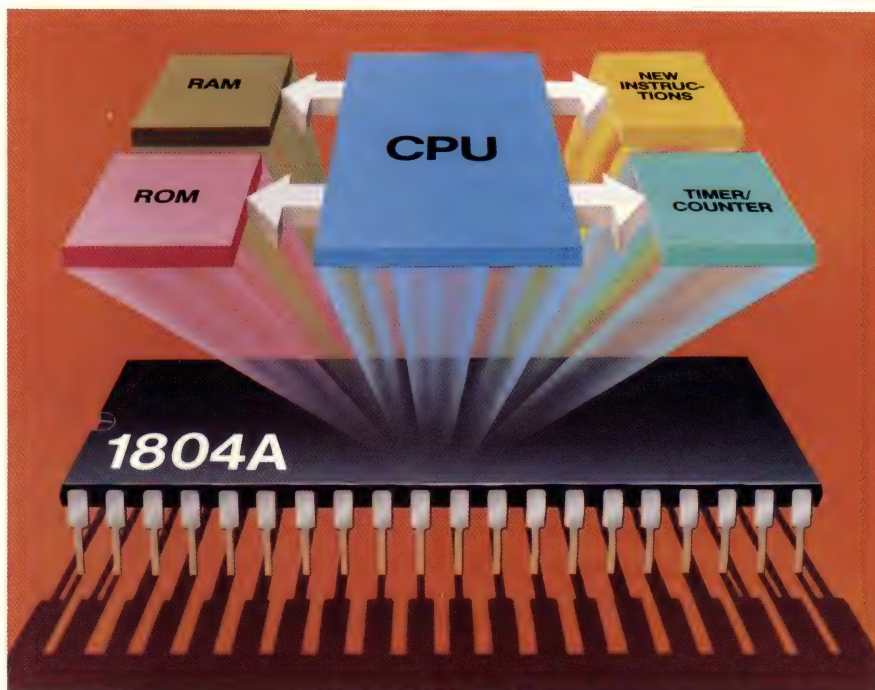
Designed using the static CMOS circuitry concept, the 1804A, 1805A and 1806A offer the lowest current consumption for both operating and quiescent conditions at 5 volts. For example, 300 μ A at 5 MHz operating and 50 μ A quiescent. This contrasts with micro designs that utilize dynamic or quasi-CMOS circuitry which need more than 15 times greater current in both operating and quiescent modes.

Execution time for the RCA 1804A is only 3.2 μ s at 5 MHz. The internal 2K ROM may be deactivated for prototyping or test and debugging purposes.

In addition to program storage, the internal ROM on the 1804A can hold system firmware such as operating system high-level language, math routines and user-defined routines.

Our 123 powerful instructions help to make the 1804A exceptionally easy to use. Included are a full set of BCD instructions, improved call and return instructions that minimize processing time, a 16-bit data instruction for faster data transfer, and a save instruction for improved interrupt servicing.

The CPU chip contains an array of 16-bit scratchpad registers that provide control over memory addressing and



The powerful 1804A micro is the latest addition to the RCA 1800 family.

internal housekeeping. This scratchpad can be programmed indirectly through three 4-bit register designators. Memory locations are also addressed by loading address values into the scratchpad registers.

One feature that really sets the RCA 1804A CMOS 8-bit Microcomputer apart from competitive devices is its ability to accommodate external RAM and ROM—any combination up to 64K. It includes an 8-bit multiplex address bus which can be used to generate 64K bytes of possible addresses to memory. A separate bidirectional bus is used for data transfer. A latch pulse, TPA, is provided to capture the high-order address byte to provide a stable address to external memory. Special ROMs are available to eliminate the need for an external latch for this purpose.

The I/O structure is unique, with a separate I/O address bus, four flag inputs and one interrupt input, and a single Q-bit output port.

The I/O structure allows for stack transfer directly to and from memory,

while the flag and Q lines can be used as I/O pins under software control, or in serial I/O applications.

In addition, DMA request inputs are provided for control of an on-board DMA counter. The DMA feature allows the CPU section to generate address and control signals for memory/I/O transfer in a continuous or cycle-stealing mode. This feature may also be used to provide a real-time clock function under hardware-update control.

To sum up, nothing else on the market offers you all this capability in one package:

- 100% static CMOS circuitry
- Very low quiescent current: 50 μ A typical
- Very low operating current: 300 μ A typical
- 2K bytes of mask-programmable ROM
- 64 bytes of RAM
- 8-bit counter-timer operating in 6 different modes
- Enhanced interrupt controller
- Crystal or RC-oscillator capability

- 5-MHz crystal clock
- Call-and-return instructions
- 16-bit data instruction
- 3.27- μ s instruction fetch-execute time
- 123 powerful instructions
- Extended temperature range: -55°C to +125°C
- Dual-channel event counting and pulse-width measurement
- Can address 64K bytes of external memory
- Can be used as timebase with clock source from prescaled TPA signal
- Can configure in unique modes for special functions
- Can plug into existing RCA 1800-series sockets

A full line of CMOS μ Ps.

There are many applications in which a CMOS microprocessor is the optimum choice. Our μ P line includes the 1802A: the most popular CMOS microprocessor in history. In fact, we shipped more than two million 1802 μ Ps in 1981. That's more than all competitive CMOS 8-bit μ P shipments combined! And the number of 1802A applications is still growing.

The diagram to the right shows the basic architecture of these devices.

CDP1802A.

CPU with 91 instructions and 3.2 MHz clock rate.

CDP1802B.

CPU with 91 instructions and 5.0 MHz clock rate.

CDP1804A.

5.0 MHz CPU with 123 instructions plus 2K ROM, 64 bytes RAM and 8-bit counter/timer.

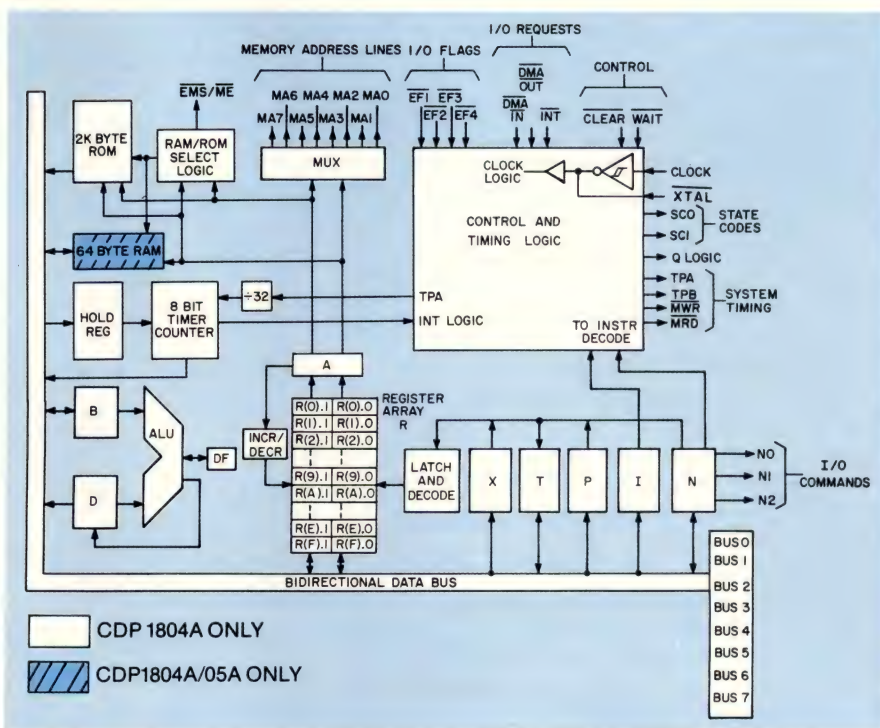
CDP1805A.

5.0 MHz CPU with 123 instructions plus 64 bytes RAM and 8-bit counter/timer.

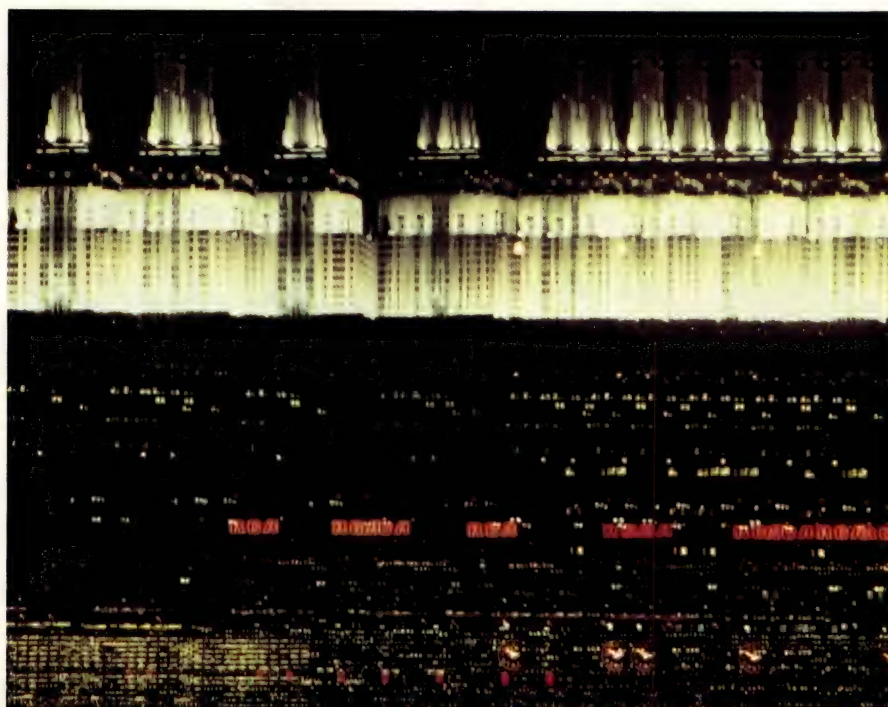
CDP1806A.

5.0 MHz CPU with 123 instructions plus 8-bit counter/timer.

For those military applications needing silicon-on-sapphire characteristics, RCA offers the CDP1805 and CDP1806, which operate at 4.0 MHz and have 113 instructions.



Block diagram of the RCA CDP1804A.



Last year RCA shipped more than two million 1802 micros ... enough to stack higher than 29 Empire State Buildings.

Our processing power is backed by dozens of CMOS memories and CMOS peripheral devices.

In addition to powerful CMOS microprocessors, RCA's broad and expanding 1800 series incorporates the most complete line of CMOS memory and peripheral devices in the industry, and affords the system designer exceptional flexibility in hardware/software tradeoffs. These building-block elements include a broad complement of byte organized random-access memories (RAMs) and read-only memories (ROMs), complex I/O functions, serial communication, CRT control, latch and decoder interfaces, and numerous other functions to meet the needs of almost any CMOS 8-bit micro applications.

This extensive line of building-block elements, together with the powerful and versatile 1800-series processing units, make possible the design of a wide variety of all-CMOS systems for many highly diverse types of applications, limited only by the ingenuity of the system designer.

CMOS static RAMs.

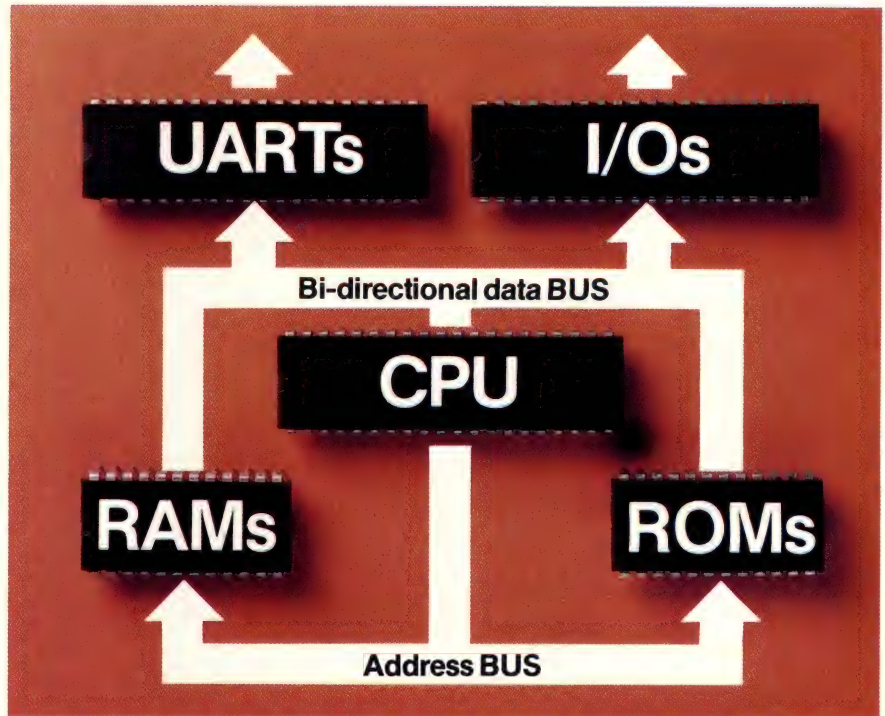
A complete line of fully static CMOS RAMs, including several with industry-standard pinouts, are available for use in 1800-series CMOS micro systems.

RAM densities range from 32 bits to 16K bits and many are byte organized. They feature the inherent CMOS advantages of low operating power and low standby current and are capable of memory retention for a minimum standby battery voltage of only 2 volts.

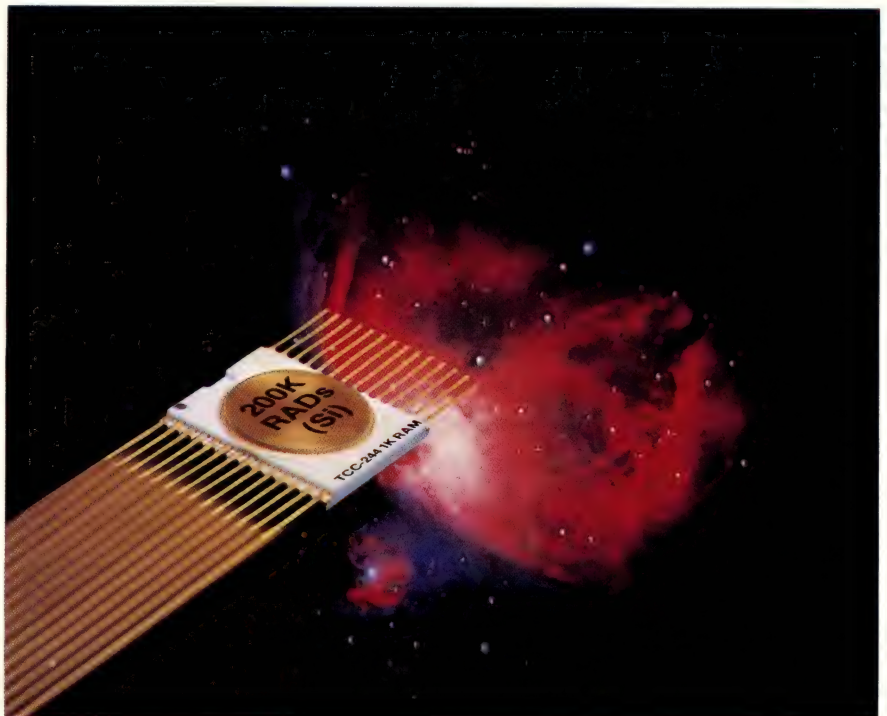
Mask-programmable CMOS ROMs.

The RCA 1800-series CMOS ROMs are byte-wide, mask-programmable devices that are ideal for very low-power nonvolatile data storage in CMOS 8-bit systems. These ROMs range in size from 512 to 32K bytes and many of these are mask-programmable with respect to address location and/or polarity of the chip select.

ROM program patterns can be submitted by use of a master device (PROM or EPROM), a floppy disk generated on an RCA 1800-series development system, or computer punch cards.



The expanding RCA 1800 series continues to grow to meet new customer needs.



Almost all 1800-series devices are available in High-Rel versions for demanding applications.

Full family of peripherals.

Exceptional system versatility is made possible by a full family of CMOS logic, I/O and other peripherals. Many of these devices offer unique system functions that greatly facilitate the task of the system designer.

UARTs. Programmable UARTs are included for interfacing computers or microprocessors to asynchronous data channels. The receiver converts serial-start, data, and stop bits into parallel data verifying the proper code transmission, parity, and stop bits. The transmitter converts parallel data into serial form and automatically adds start, parity and stop bits. The data word length can be 5, 6, 7, or 8 bits. Parity may be odd or even. Parity checking and generation can be inhibited. Stop bits can be 1, 1½, or 2 bits.

Multiply/divide unit. The CDP1855 MDU is an efficient hardware replacement for the software-only implementation of arithmetic and signal-processing algorithms.

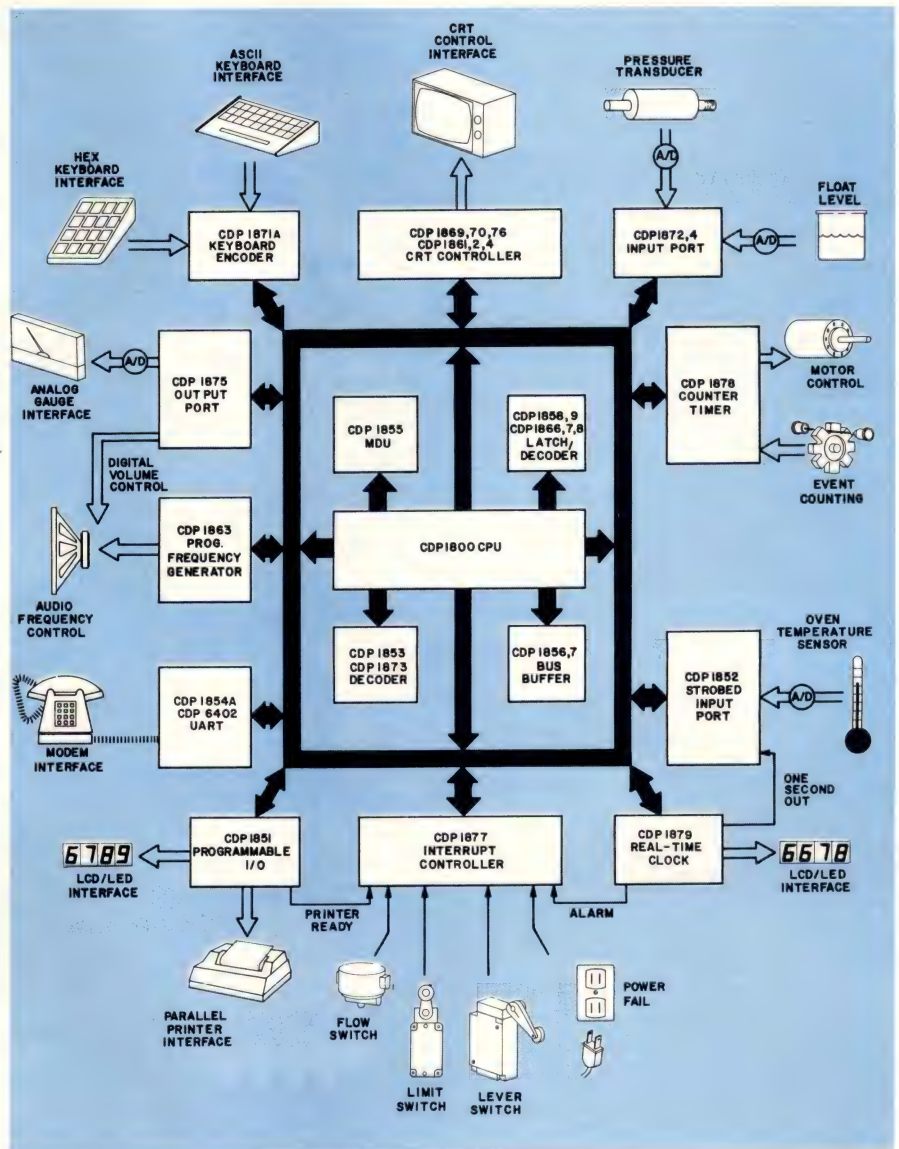
It performs multiply and divide operations on 8-bit data with an add-and-shift type of hardware implementation and is structured to permit cascading of identical units to handle operations up to 32 bits.

CMOS counter/timer. A highly versatile dual counter/timer (CDP1878), features five counter modes that, together with different combinations of gating levels, output polarity, and under-flow interrupt indication, provide a complete array of timing, pulse forming, and event-counting programming.

This unit consists of two 16-bit programmable down counters that function independently in one of the five modes. Three address pins are available to select the counters or separate control and status registers. Each counter has complemented outputs that are activated as the operating mode requires, and a common maskable interrupt output is provided for handshaking functions.

CMOS real-time clock. A new real-time clock (CDP1879) operates with several different crystal frequencies and has a separate clock output that can supply subsecond-to-day square-wave outputs together with an interrupt request.

The circuits include an alarm circuit that can be set for seconds, minutes or



The RCA 1800-series peripherals enable you to interface a wide variety of systems to the outside world.

hours. A status register keeps track of alarm and clock status when interrupts are disabled.

CMOS video interface. A two-chip interface system (CDP1869 and CDP1870 or CDP1876) can be used to control screen formatting, screen-refresh memory, and synchronization of a master-scan CRT color display.

The CDP1869 handles the system interface with the CPU and provides the memory interface timing. The CDP1870 or CDP1876 handles the TV synchroni-

zation and color subcarrier information.

And others. The extensive line of 1800-series peripherals also includes keyboard encoders, programmable frequency generators, video-display controllers, input and output ports, latch and decoder interfaces, buffer separators, programmable I/O interfaces and other functions. These peripheral units are designed to take maximum advantage of the capabilities of the 1800-series CPUs, with the application possibilities almost unlimited.

We make it easy for you to get started in CMOS microprocessing.

The 1800 series includes a full line of CMOS microprocessor development and support systems, with an extensive line of hardware, software, and accessory items. This series offers the following basic features:

- Full spectrum of design aids, including software, hardware, support, and literature
- Low-cost systems (CDP18S693/4/5) for complete system design and debugging functions
- Readily available hardware and software applications support
- "Graduated steps" to microprocessor design
- Complete series of technical manuals and other literature that provide detailed explanations of the operation and use of various hardware and software systems.

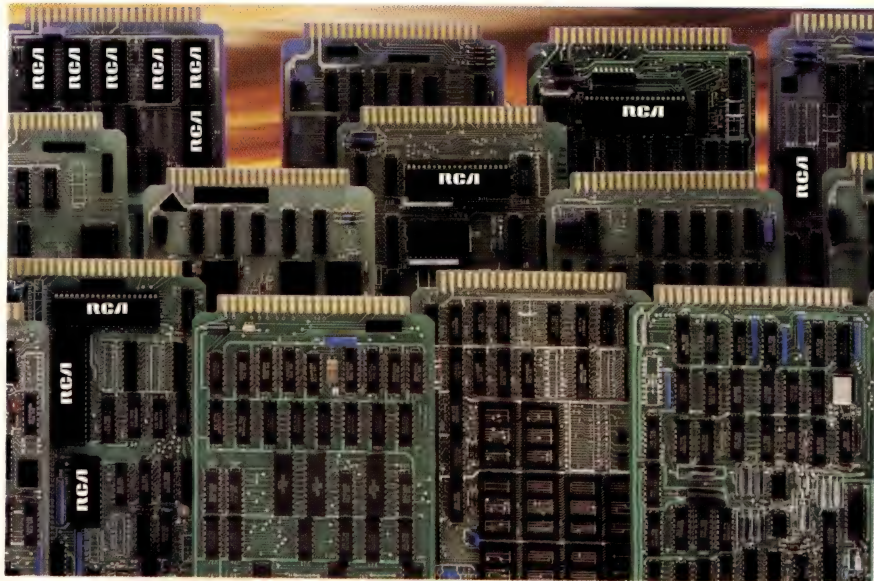
RCA's approach in the development of the CDP18S-series hardware and software has been "graduated steps to microprocessing." With respect to both function and dollar investment, the user is given logical steps that help him progress from a learning stage on through integral hardware/software system prototyping.

The RCA MicroDisk Development System, MS2000, utilizes 3½" disks and provides 645 kilobytes of on-line mass memory storage, and features higher speeds than its predecessors.

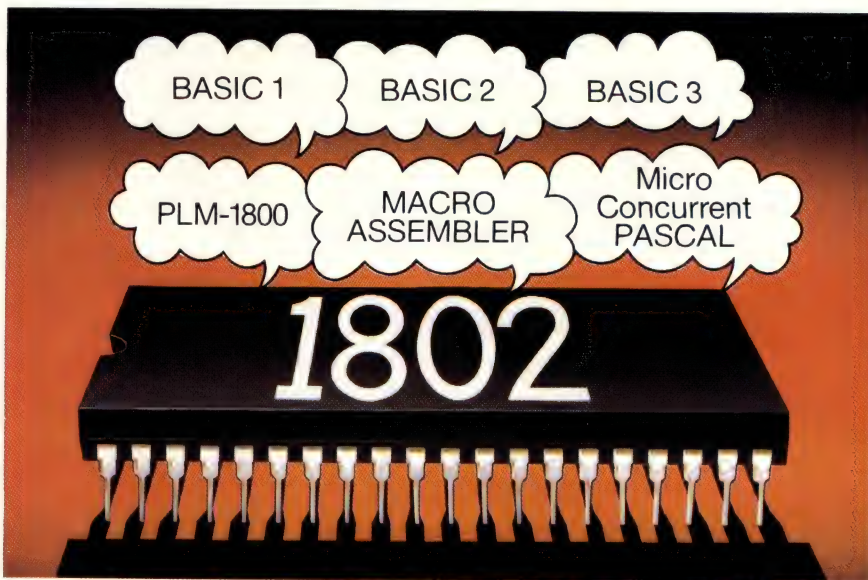
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Design Ideas

where F_C is the input clock frequency.

By substituting **Eq 2** into **Eq 1** and differentiating, you can express X 's first derivative as a function of F_C and X :

$$\frac{dX}{dt} = \frac{F_C}{X} \quad (3)$$

This equation's solution demonstrates **Fig 1**'s operation by yielding X as a function of $\sqrt{t}$:

$$X = \sqrt{2F_C t + C_1}, \quad (4)$$

where C_1 equals a constant proportional to X 's value at the start of the square rooter's operation. (C_1 equals zero if the output counter gets reset by the time-interval input.)

A practical implementation of the $\sqrt{t}$ generator (**Fig 2**) employs four 74192 BCD counters: Two counters (IC_1 and IC_2) form the variable-modulo divider, and the other two devices (I_3 and I_4) serve as output counters. A HIGH level at the time-interval input starts the circuit by resetting the output counters and loading a binary zero into the divider chain. The first HIGH-to-LOW input-clock transition drives IC_2 's Borrow output LOW, setting X equal to 00000001 and increasing the divider's modulo value. The cycle continues with X increasing one count each time IC_2 's Borrow output goes LOW, until a LOW level at the time-interval input stops the circuit. You can store X 's final value before IC_3 and IC_4 reset by triggering a data latch on time-interval-input HIGH-to-LOW transitions.

The square rooter's output resolution equals 10^K points, where K equals the number of BCD counters used in the output chain; **Fig 2**'s circuit, therefore, generates 100 data points. By substituting the output's maximum value (X_{MAX}) into **Eq 4**, you can derive the circuit's maximum measurable time-interval pulse (t_{MAX}) as a function of the input clock frequency:

$$F_C = \frac{10^{2K}}{2t_{MAX}} \quad (5)$$

Thus, decreasing the clock frequency extends the circuit's measuring capability for a given output resolution. Low clock frequencies, however, result in diminished accuracy, so you must carefully choose both counter resolution and F_C to optimize measurement-resolution and input-range tradeoffs for your application.

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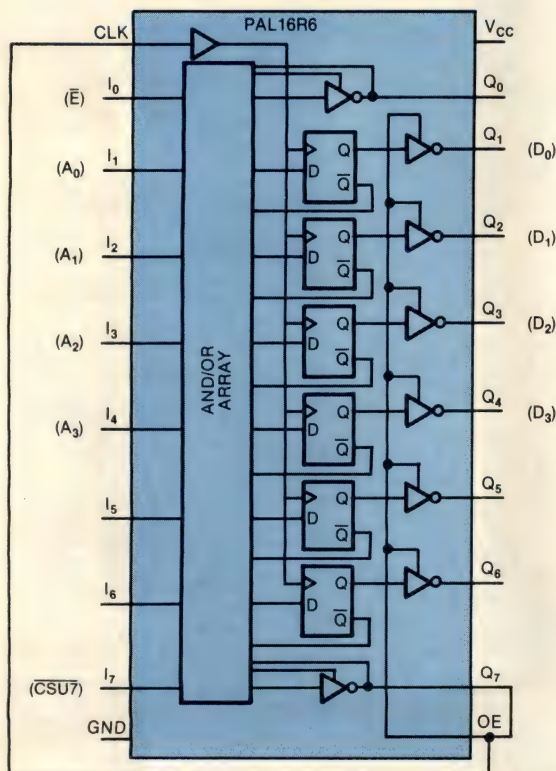


PAL chip hinders software copying

Keith A Miller

Data I/O, Redmond, WA

An inexpensive programmable-array-logic (PAL) device, added to each hardware system you sell, can discourage purchasers from using unauthorized copies of your software: You just add some special code to your software that renders it inoperable unless the PAL, containing an encrypted key, is present. A different PAL program in each system, matched to software sold specifically for that system, prevents moving software to systems that aren't authorized to run it. Deciphering and modifying the software to circumvent the security usually requires more effort than an unauthorized user is willing to expend.



NOTE: $\bar{E}$ AND $\overline{CSU7}$ ARE SYSTEM BUS SIGNALS.

Fig 1—A programmable-array-logic device (PAL) can store a Boolean-expression key that allows specially prepared software to run on a system containing the device. Systems that don't contain a properly programmed PAL can't run the software.

INPUT	FUNCTION
00	INITIALIZE (SET OUTPUTS TO ZERO)
01	COMPLEMENT
02	LOGICAL SHIFT RIGHT
03	ARITHMETIC SHIFT LEFT
04	LOGICAL AND WITH INPUT
05	LOGICAL OR WITH INPUT
(a) ALL OTHERS	FORCE ALL OUTPUTS TO ONE

$$\begin{aligned}
 /Q1: &= /I1 \star /I2 \star /I3 \star /I4 \\
 &+ /I1 \star /I2 \star /I3 \star /I4 \star Q1 \\
 &+ /I1 \star /I2 \star /I3 \star /I4 \star /Q2 \\
 &+ /I1 \star /I2 \star /I3 \star /I4 \\
 &+ /I1 \star /I2 \star /I3 \star /I4 \\
 /Q2: &= /I1 \star /I2 \star /I3 \star /I4 \\
 &+ /I1 \star /I2 \star /I3 \star /I4 \star Q2 \\
 &+ /I1 \star /I2 \star /I3 \star /I4 \star /Q3 \\
 &+ /I1 \star /I2 \star /I3 \star /I4 \star /Q1 \\
 &+ /I1 \star /I2 \star /I3 \star /I4 \\
 &+ /I1 \star /I2 \star /I3 \star /I4 \star /Q2 \\
 /Q3: &= /I1 \star /I2 \star /I3 \star /I4 \\
 &+ /I1 \star /I2 \star /I3 \star /I4 \star Q3 \\
 &+ /I1 \star /I2 \star /I3 \star /I4 \star /Q4 \\
 &+ /I1 \star /I2 \star /I3 \star /I4 \star /Q2 \\
 &+ /I1 \star /I2 \star /I3 \star /I4 \star /Q3 \\
 /Q4: &= /I1 \star /I2 \star /I3 \star /I4 \\
 &+ /I1 \star /I2 \star /I3 \star /I4 \star Q4 \\
 &+ /I1 \star /I2 \star /I3 \star /I4 \star /Q4 \\
 &+ /I1 \star /I2 \star /I3 \star /I4 \star /Q3 \\
 &+ /I1 \star /I2 \star /I3 \star /I4 \\
 &+ /I1 \star /I2 \star /I3 \star /I4 \star /Q4 \\
 \text{IF (VCC) } /Q7: &= /I0 \star /I7
 \end{aligned}$$

Fig 2—By using a logic programmer to store functions (a) in a PAL, you can create keys for accessing the functions' corresponding sum-of-products expressions (b).

The key contained in the PAL is actually an implementation of a sum-of-products Boolean expression that you choose and program into the PAL. Once programmed, the PAL applies its input signals to the expression and places the results on its output lines. Your specially prepared software need only apply occasional inputs to the PAL and verify that the PAL's output values are the expected ones. You can program the software to halt with an error message if the wrong values appear.

A logic diagram for a PAL (the PAL16R6 from Monolithic Memories Inc) appears in Fig 1. This particular device allows you to implement a sum-of-products expression with as many as eight inputs (although only four are used in this example) plus previous-state feedback. You convert the expression to a fuse map, using Monolithic Memories's PALASM program, and then transfer the map into the PAL using a logic programmer such as the Data I/O LogicPak. Blowing the PAL's last fuse (a device

Continued on pg 313

Win Big!

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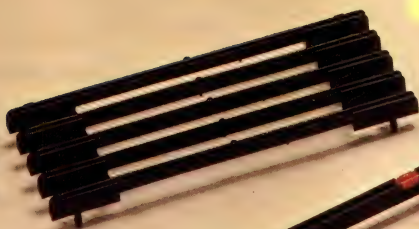
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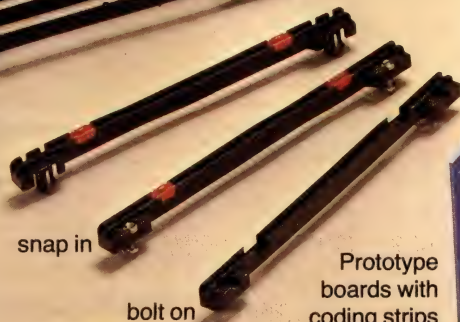


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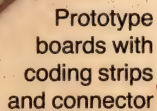
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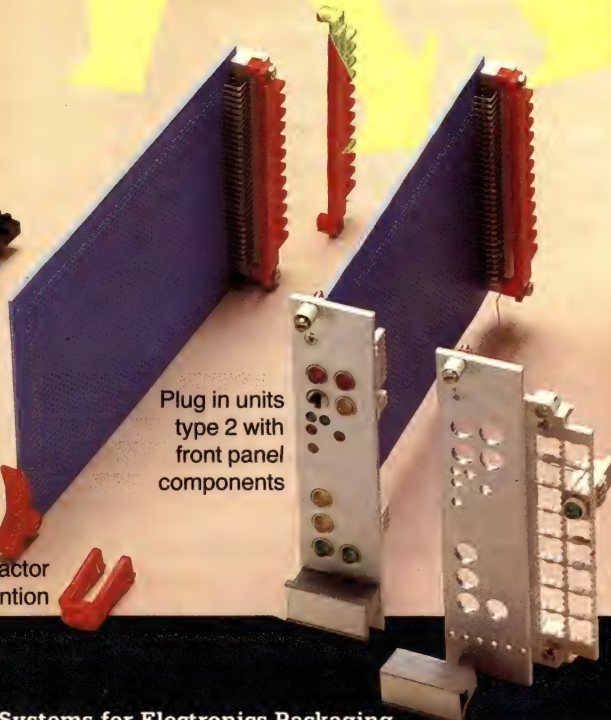
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that when not blown permits PAL-logic verification) prevents anyone from reading the program.

In the Fig 1 example, the PAL occupies 16 bytes of address space. The lower four address lines (A₀ through A₃) serve as inputs, and the PAL's outputs appear on the corresponding data lines (D₀ through D₃). A chip-select signal, ORed with system-bus

signal $\bar{E}$, clocks the input with its rising edge and enables the output when it goes LOW. Because the signal provides LOW-going pulses, outputs are actually responses to previous inputs.

Fig 1's example is actually a state-machine implementation that performs functions on the previous outputs. Examples of functions you can

```

*****
*                               SOFTWARE LOCK ROUTINE
*****
*DESTROYS:A,B,X AND Y REGISTERS
*I/O:OUTPUT ADDRESS TO PAL AND INPUT DATA FROM PAL
*DESCRIPTION:
*THIS ROUTINE SIMPLY DEMONSTRATES THE ACCESS OF THE
*SOFTWARE LOCK. A FIVE VECTOR INPUT BUFFER IS LOADED
*AND PRESENTED TO THE LOCK (PAL). THE RESPONSE IS
*VERIFIED AND EITHER "SOFTWARE LOCK INSTALLED PROPERLY"
*OR "SOFTWARE PROTECTION WAS VIOLATED" IS OUTPUT TO
*THE TERMINAL. IN A REAL APPLICATION THIS ROUTINE WOULD
*BE SPREAD THROUGHOUT THE MAIN SOFTWARE TO PREVENT EASY
*DECODING.
*****
0800  BUFFER EQU    $0FF0
E800  PAL      EQU    $E800
F814  MONITOR EQU    $F814
F80C  PDATA   EQU    $F80C

0800  ORG      $0800
0800 108E 0FF0  LDY    #BUFFER    SET POINTER FOR INPUT VECTORS
0804 8E    E800  LDY    #PAL      SET POINTER FOR LOCK
0807 CE    088F  LDU    #OUTPUT   SET POINTER FOR GOOD OUPUT DATA
080A 86    05    LDA    #$05     LOAD UP THE INPUT VECTOR BUFFER
080C A7    A4    STA    0,Y
080E 80    02    SUBA   #$02
0810 A7    21    STA    1,Y
0812 A7    22    STA    2,Y
0814 80    02    SUBA   #$02
0816 A7    23    STA    3,Y
0818 4C                    INCA
0819 A7    24    STA    4,Y

081B 5F                    CLRB    INITIALIZE VECTOR COUNTER
081C B7    E800  STA    PAL      SEND OUT INITIALIZE VECTOR TO LOCK
081F A6    A4    L1      LDA    0,Y  GET INPUT VECTOR
0821 6F    A0    CLR    0,Y+    CLEAR INPUT VECTOR
0823 30    86    LEAX   A,X     ADD VECTOR TO LOCK ADDRESS
0825 A6    84    LDA    0,X     ACQUIRE OUTPUT FOR LAST INPUT STIMULUS
0827 84    0F    ANDA   #$0F    MASK OFF LOWER FOUR BITS
0829 A1    C0    CMPA   0,U+    COMPARE TO GOOD DATA
082B 26    0A    BNE    ERROR   NOT EQUAL...PROTECTION VIOLATED
082D 5C                    INCB   BUMP VECTOR COUNTER
082E C1    06    CMPB   #$06    DONE WITH TEST?
0830 27    0F    BEQ    EXIT    IF YES...PRINT OKAY MESSAGE
0832 8E    E800  LDY    #PAL     RESTORE POINTER TO LOCK
0835 20    E8    BRA    L1      CHECK NEXT INPUT

0837 8E    084B  ERROR  LDY    #ERRORMES POINT TO ERROR MESSAGE
083A AD    9F F80C  JSR    [PDATA] OUTPUT MESSAGE
083E 7E    F814  JMP    MONITOR  BACK TO THE MONITOR

0841 8E    086D  EXIT   LDY    #OKAY  POINT TO OKAY MESSAGE
0844 AD    9F F80C  JSR    [PDATA] OUTPUT MESSAGE
0848 7E    F814  JMP    MONITOR  BACK TO THE MONITOR

084B 53 4F 46 54  ERRORMES FCC  "SOFTWARE PROTECTION WAS VIOLATED "
086C 04                    FCB      $04
086D 53 4F 46 54  OKAY   FCC      "SOFTWARE LOCK INSTALLED PROPERLY "
088E 04                    FCB      $04

088F 00 05 0A 04  OUTPUT FCB      $00,$05,$0A,$04,$0B,$05 VALID OUTPUT

0 ERROR(S) DETECTED

SYMBOL TABLE:
BUFFER 0FF0  ERROR 0837  ERRORM 084B  EXIT  0841  L1  081F
MONITO F814  OKAY  086D  OUTPUT 088F  PAL  E800  PDATA F80C

```

Fig 3—This simple routine, callable from your software, presents a stimulus to the PAL and checks for the expected response. An incorrect response halts the program and generates an error message.

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EXAMPLE	INPUT				OUTPUT			
	A ₃	A ₂	A ₁	A ₀	D ₃	D ₂	D ₁	D ₀
1	0	0	0	0	-	-	-	-
	0	1	0	1	0	0	0	0
	0	0	1	1	0	1	0	1
	0	0	1	1	1	0	1	0
	0	0	0	1	0	1	0	0
	0	0	1	0	1	0	1	1
2	-	-	-	-	0	1	0	1
	1	0	0	0	-	-	-	-
	0	1	0	1	1	1	1	1
	0	0	1	1	1	1	1	1
	0	0	1	1	1	1	1	1
	0	0	0	1	1	1	1	1
3	0	0	1	0	0	0	0	0
	0	1	0	0	0	1	0	1
	0	0	0	1	0	1	0	0
	0	0	1	1	1	0	1	1
	0	0	0	1	0	1	1	0
	-	-	-	-	1	0	0	1
4	0	1	1	1	-	-	-	-
	0	1	0	0	1	1	1	1
	0	0	1	0	0	1	0	0
	0	0	0	1	0	0	1	0
	0	0	1	1	1	1	0	1
	1	0	1	0	1	0	1	0
5	-	-	-	-	1	1	1	1
	0	0	0	0	-	-	-	-
	0	0	0	1	0	0	0	0
	0	1	0	1	1	1	1	1
	0	0	0	1	1	1	1	1
	0	1	0	0	0	0	0	0
	0	0	1	1	0	0	0	0
	-	-	-	-	0	0	0	0

Fig 4—These PAL inputs and outputs represent stimuli and responses, respectively, for the Fig 2 functions.

choose appear in Fig 2a, and their corresponding sum-of-products expressions for programming the PAL appear in Fig 2b.

Fig 3 contains a simple example of the software used to access the PAL. This routine loads a buffer of valid PAL addresses (which serve as input vectors), presents vectors to the PAL, verifies correct PAL output and displays a message indicating whether or not a correct PAL is installed in the system. Some example input vectors and the corresponding responses expected from the PAL appear in Fig 4.

Some additional steps can make this approach even more secure against unauthorized software use; one method involves modifying the PAL input vectors at various points in the software. By making the last modification just before presenting a PAL input and then destroying the vectors immediately after their input, you can make the code quite difficult to break. Using a logic analyzer to break the code, for example, requires triggering within a narrow window to catch the valid input vectors. Having your software make dummy reads from the PAL could add still another dimension of complexity.

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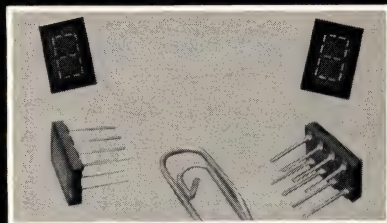
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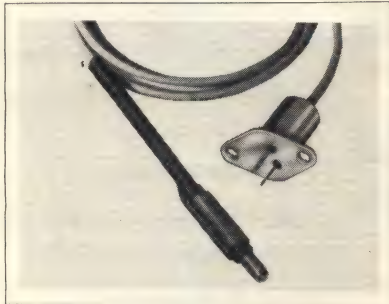
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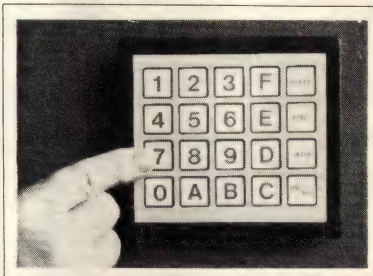
Components & Packaging



INJECTION LASER. Model C86037E InGaAsP cw laser diode furnishes a 1300-nm output wavelength, well matched with the wavelength of the near-maximum response of Ge and InGaAs/InP photodiodes. Capable of high-duty-cycle pulse operation, it comes with a 1m fiber-optic cable internally coupled to the laser chip emitting region. A modified TO-66 package allows easy mounting and good thermal dissipation. An InGaAs/InP photodiode monitors

laser output; the photocurrent produced by this diode suits use in a negative-feedback op amp to stabilize laser output. \$1950. **RCA, Electro-Optics and Devices, Box 3200, Somerville, NJ 08876. Phone (717) 397-7661.**

Circle No 257



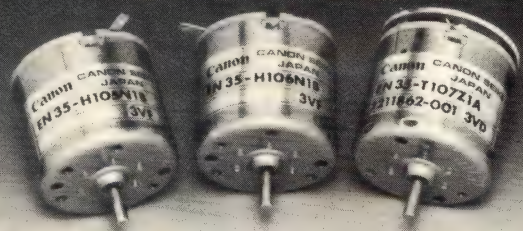
KEYPADS. With user-selectable 3-state or latched-mode BCD outputs, EMK 16 and EMK 20 Series units allow the addition of 16 or 20 keyswitches to a system without extensive software de-

coding. Debounce and 2-key-rollover circuits are included; both Data Available outputs are TTL and CMOS compatible. The switches furnish tactile feel with replaceable legends on 0.875-in. centers. They require 5 to 18V dc. EMK 16, \$68; EMK 20, \$74. **Mantex Corp, Box 15, Oxford, MI 48051. Phone (313) 628-9711.**

Circle No 258

16-BIT ADCs. Models ADC73 and ADC731 successive-approximation units are linear to within $\pm 0.0015\%$ FSR in J versions or $\pm 0.00075\%$ FSR in K models. Conversion time equals 170 μ sec max and 150 μ sec typ, and there are no missing codes over 15 to 35°C. Each unit comes with a precision internal reference and compara-

DC motors



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Selected by many major computer manufacturers

- Compact size, 35mm dia. $\times$ 31.6mm long
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- Long life - self lubricated bearings
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- AMP 110 quick connect terminals
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- Special filter network available
- Gear motor available for 111 Series

Designed specifically for computer peripheral applications this series of DC motors offers exceptional long life through use of a 3mm diameter shaft for improved rigidity which permits higher side loadings and a sintered bronze bearing that is self-lubricated from a felt washer that serves as an oil reservoir. An optional electrical filter network is available for extremely low noise.

Typical applications include point of sale terminal printers, ribbon drives, paper feeders, card readers, video disk and tape drives. Special models (specs not shown) are available for use as fan motors.

See us at Southcon, Booth 943-945

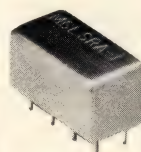
Canon

Canon U.S.A., Inc.
Electronic Components Division
One Canon Plaza
Lake Success, New York 11042
Tel: (516) 488-6700
Telex: 96-1333
Cable: CANON USA LAKS

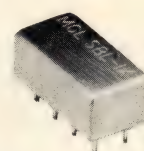
MODEL NO.	Rated				Starting Torque g-cm	No Load		Motor Constant g-cm/A	Terminal Resistance ohms
	Voltage V	Torque g-cm	Speed rpm	Current mA		Speed rpm	Current mA		
EN35-R105N1B	6	40	3500	490	150	4500	135	121	4.0
EN35-T105N1B	12	40	3500	230	160	4500	65	247	14.4
EN35-H105N1B	24	40	3500	135	160	4500	55	488	57.0
EN35-T111N1B	12	40	5000	300	190	6000	80	189	10.0
EN35-H111N1B	24	40	5000	170	190	6000	65	378	39.0
EN35-T151N1B	12	40	5700	370	265	6600	100	169	6.6
EN35-H151N1B	24	40	5700	190	310	6500	80	366	24.0



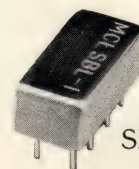
pick a mixer



SRA-1



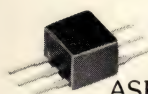
SBL-1X



SBL-1



TFM-2



ASK-1

standard level (+7dBm LO)
from 500 KHz to 1GHz... hi-rel and industrial
miniature, flatpack, and low profile from \$3⁹⁵

Choose from the most popular mixers in the world. Rugged construction and tough inspection standards insure MIL-M-28837/1A performance.*

Check these features...

- SRA-1 the world standard, covers 500 KHz to 500 MHz, Hi-REL, 3 year guarantee, HTRB tested, MIL-M-28837/1A-03 S performance* \$11.95 (1-49).
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- SBL-1X industrial grade, low cost, \$4.95 (10-49) 10 to 1000 MHz, rugged all metal enclosure.
- ASK-1 world's smallest double-balanced mixers, 1-600 MHz, flat-pack mounting, plastic case, \$5.95 (10-49).

*Units are not QPL listed

MODEL	SRA-1	TFM-2	SBL-1	SBL-1X	ASK-1
FREQUENCY, MHz					
LO, RF	.5-500	1-1000	1-500	10-1000	1-600
IF	DC-500	DC-1000	DC-500	.5-500	DC-600
CONVERSION LOSS, dB					
one octave bandedge	6.5	6.0	7.5	7.5	7.0
total range	8.5	7.0	8.5	9.0	8.5
ISOLATION, dB, L TO R					
lower bandedge	50	50	45	45	50
mid range	40	40	35	30	35
upper bandedge	30	30	25	20	20

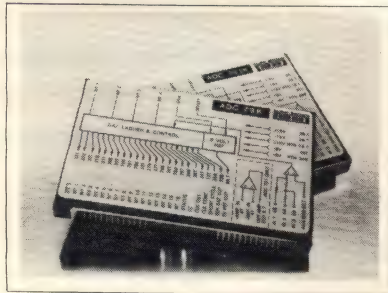
For complete specifications and performance curves refer to the 1980-1981 Microwaves Product Data Directory, the Goldbook or EEM.

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Components & Packaging



tor and an ultrastable clock; Model ADC731 also includes a unity-gain instrumentation amp to provide a precision high-impedance differential input buffer. Unipolar input ranges of 0 to 10V or bipolar input ranges of ± 5 or ± 10 V are pin programmable; built-in trim potentiometers

allow complete calibration adjustment. Control signals and output data lines are TTL compatible over 0 to 70°C. Output data is available as a parallel word with corresponding clock and status outputs. $3 \times 4.7 \times 0.4$ -in. metal cases shield the devices from electrical and magnetic interference. ADC73J, \$251; ADC73K, \$299; ADC731J, \$286; ADC731K, \$337 (100). **Burr-Brown**, Box 11400, Tucson, AZ 85734. Phone (602) 746-1111.

Circle No 259

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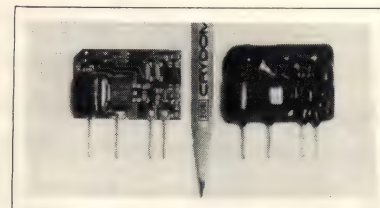
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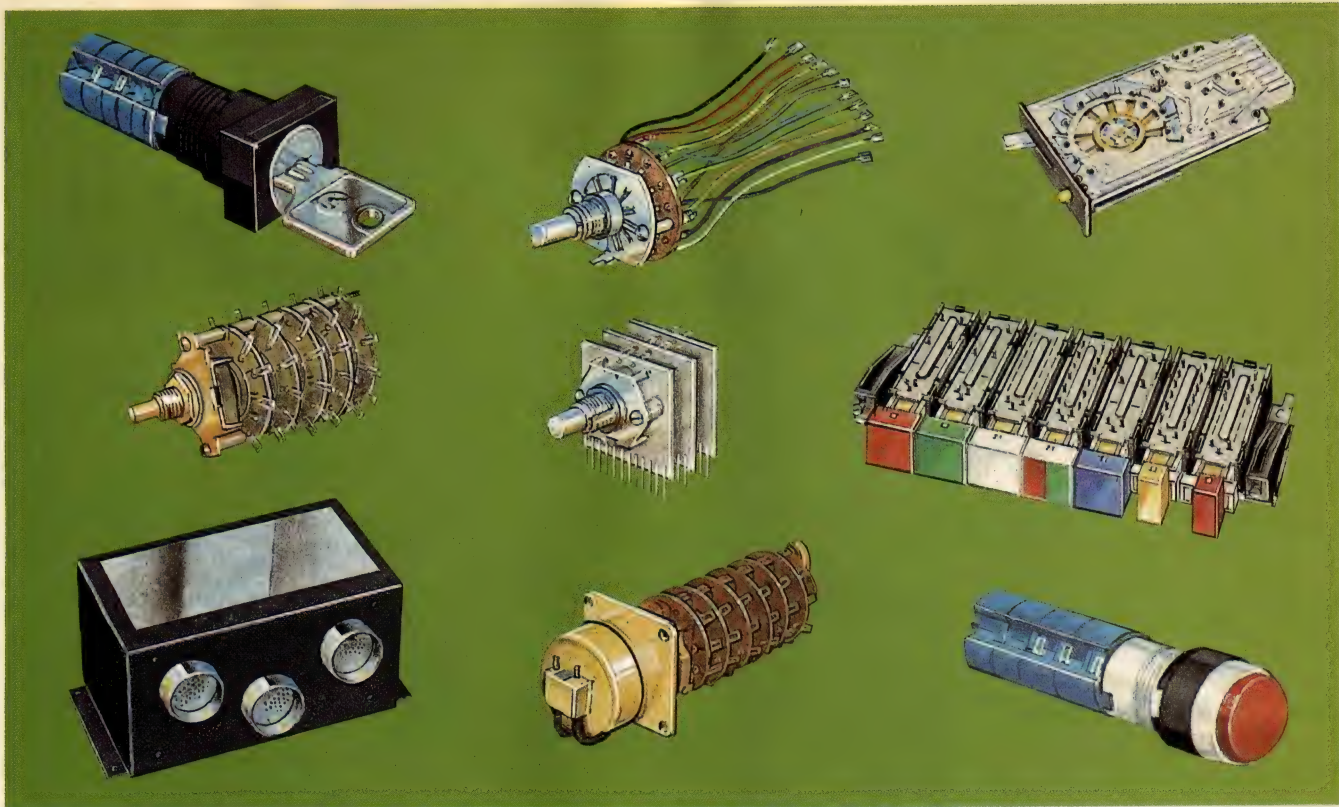
CIRCLE NO 106



SOLID-STATE RELAY. Model D2W operates over 60 to 280V and specs a 2A current rating with a 3 to 28V dc input operating range. Input impedance equals 1500Ω , and the device requires <2 mA to operate. Housed in a SIP that's socket compatible with industry-standard I/O configurations, the unit comes coated with a permanent epoxy seal, allowing operating temperatures to 80°C. \$7.95. **Crydom Div, International Rectifier**, 1521 Grand Ave, El Segundo, CA 90245. Phone (213) 322-4987. TWX 910-348-6283.

Circle No 260

LOW-PRESSURE TRANSDUCER. The 160PC Series device responds accurately to pressure changes in the 0 to 1-psig range via an expanded 0.175-in.-square silicon-sensor chip. Furnished in gauge and differential models, it provides a combined 1% null and sensitivity error over



Increase Your Switch Design Flexibility

"I'm tired of mushy, cap-popping, memory losing, raggedy, poorly lit, hard to wire, static generating, field failing, cheap and dirty switches."

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reliability where it counts.**



CIRCLE NO 107

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High speed data acquisition can be a real headache. Especially during peak I/O rates when transfer can exceed the CPU's capacity and key bits of information go off in thin air.

So we developed a DR11-W module. First for the Unibus. Now for the Q-Bus. Both feature our exclusive DMA Throttle that efficiently regulates data flow down to average rates to maximize overall CPU performance. But that's not all.

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- Long lines capability
- Switch selectable 22-bit addressing (Q-Bus)



- Bus Address Extension for memory transfer throughout the 4 megabyte range (Q-Bus)
- Switch selectable, level or single level interrupt arbitration (Q-Bus)
- Compatibility with 16, 18 and 22-bit backplanes (Q-Bus)

This high speed, digital input/output device is prescribed for such typical applications as:

- High speed graphics
- Digital data acquisition
- Parallel information processing
- Interprocessor linking between a Unibus and Q-Bus

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Now for Q-Bus* users too.

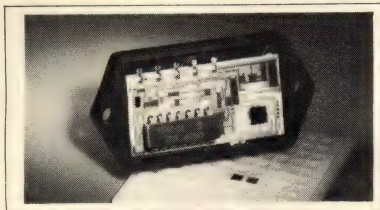
*TM Digital Equipment Corp.

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SYSTEMS INC.

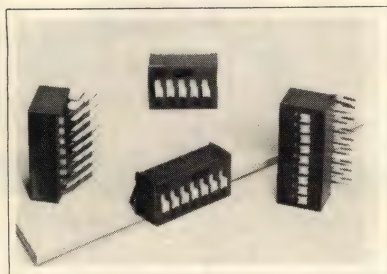
1995 N. Batavia Street, Orange, CA 92665
714-998-6900 TWX: 910-593-1339

Components & Packaging



an 80°C range. Full-scale output at 1 psi equals 5V dc. The sensor withstands shock of 50g (11 msec, half sine) and vibration to 10g (sine). Stability over 1 yr is 1/2% FS output; repeatability and hysteresis are 0.15%. Operating temperature spans -55 to +125°C; response time equals 1 msec. The chip withstands overpressure of 10 psi. \$60 (100). **Micro Switch**, 11 W Spring St, Freeport, IL 61032. Phone (815) 235-6600.

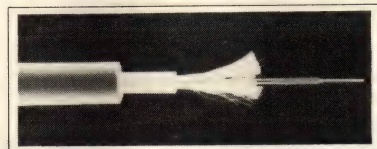
Circle No 261



DIP SWITCH. The right-angle-mount AV-style unit can mount on the edge of a pc board and be actuated through a panel; alternatively, the pc boards on which it's mounted can be stacked with very little clearance. An open-base design allows solvent cleaners and water/detergent solutions used in wave soldering to flush out all contaminants and fluxes around electrical contacts without the use of boots, caps or tapes. The device also features a positive detent mechanism to minimize the chance of accidental switching. It's available with two through 10 poles; electrical specs include a 100-mA max current rating at 50V dc (carry) and 100 mA max at 5V dc or 25 mA max at 25V dc (switch).

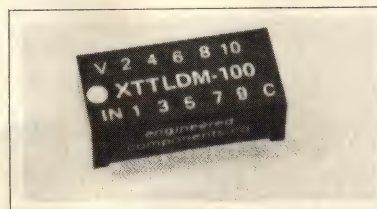
Initial contact resistance equals 0.10Ω max; capacitance is 5 pF max between adjacent stations. Life expectancy equals 10,000 operations for each circuit at operating temperatures spanning 0 to 70°C. **C&K Components Inc**, 15 Riverdale Ave, Newton, MA 02158. Phone (617) 964-6400.

Circle No 262



F-O CABLE. Model P/N LT 100-1 heavy-duty cable has a Kevlar cushion that prevents rupture and microcracks. Compatible with all industry-standard connectors, it comes in various fiber sizes and specs various optical parameters. Standard fiber is 100/140-μm glass-on-glass fully-graded-index material; optical parameters include 0.21 NA (to 3% fall-off points), 6.0-dB/km max attenuation at 850 nm and 200-MHz-km min bandwidth. Operating temperature spans -25 to +70°C. \$1.80 per metre. **Mohawk Cable Co/Optical Group**, 9 Mohawk Dr, Leominster, MA 01453. Phone (617) 537-4358.

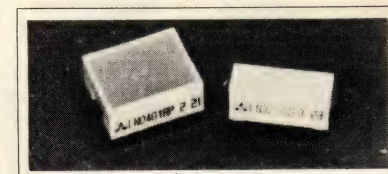
Circle No 263



DELAY MODULE. Housed in a 14-pin DIP with pick-off circuitry compatible with Schottky TTL and DTL circuits, Model XTTLDM comes in 19 delays from 50 to 1000 nsec, with each module incorporating taps at

10% increments of total delay. Delay time is measured at the 1.5V level on the leading edge. Rise time equals 4 nsec max when measured from 0.75 to 2.4V. Temperature coefficient of delay is approximately 400 ppm/°C over 0 to 70°C. The unit accepts either ONE or ZERO inputs and reproduces the logic at the selected output tap without inversion. Intended for use with positive-going pulses, each device has a driving capability of 40 TTL loads with 10 loads max on any one tap. \$14 to \$15 (100). **EC² Engineered Components Co**, Box Y, San Luis Obispo, CA 93406. Phone (805) 544-3800.

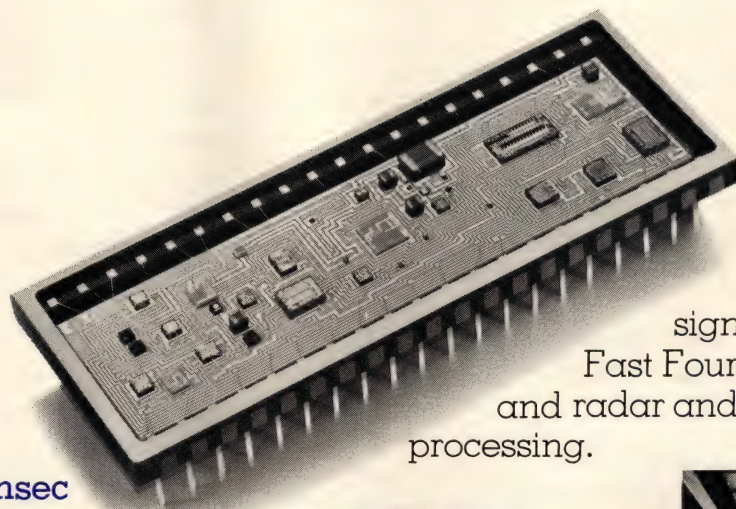
Circle No 264



LED LIGHT BARS. The Light Bars family consists of nine units: three sizes (5×12, 12×15 and 12×20 mm) with green output, three red and three amber. Capable of producing as much as 15 mcd, the units suit use in stereo sound systems, backlighting, home appliances, industrial process controllers, instrumentation and office business machines. Specifications include 2.2V dc operating voltage; 20-mA current; 5-mcd light output for red, 15 mcd for amber and green (all diffused) with 10 mA applied (12×20-mm units); 60-mW max power dissipation; and 7-mm-high profile. Operating temperature spans -25 to +80°C; storage temperature, -30 to +85°C. \$0.40 to \$1.20 (1000). Delivery, stock to 8 wks ARO. **Panasonic**, 1 Panasonic Way, Secaucus, NJ 07094. Phone (201) 348-5273.

Circle No 265

**900 NSEC
12 BIT A/D!**



MN5245

12 Bit A/D

$\pm \frac{1}{2}$ LSB Linear

Conversion Time 900 nsec

Temperature Range

-25 to +85°C

Optional MIL-STD-883 Screening

Twice as fast as any converter in its class, MN5245 is the first 900 nsec 12 Bit A/D in a DIP. It guarantees no missing codes over the full operating range, provides $\pm 0.1\%$ FSR *absolute* accuracy, and consumes only 1500 MW.

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and radar and video signal
processing.

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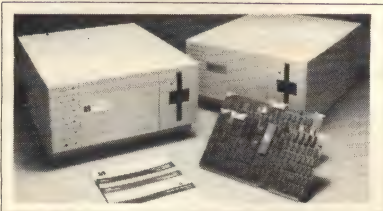


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Computers & Peripherals



NETWORK DEVICES. Providing 1M-bps system throughput, the Ethernet System Product Line (ESPL) comprises two communications computers. The Communications Server / 1 (CS/1) allows as many as 32 non-networked devices with RS-232C or RS-423 serial interfaces to connect to an Ethernet network. And the Gateway Server/1 (GS/1) connects an XNS (Xerox Network System) Ethernet network to a host or network with an X.25 interface. Both provide transparent virtual connection between all connected devices. Each unit divides

into three logical modules: the Central Communications Processor (with 128k bytes min of RAM) and two external interface modules. Each module incorporates a 16/32-bit MC68000 μ P. The IEEE-796 backplane bus serves as a data path between the three modules and accommodates system expansion. CS/1, \$9900; GS/1, \$15,000. **Bridge Communications**, 10401 Bubb Rd, Cupertino, CA 95014. Phone (408) 446-2981.

Circle No 266

VIDEO TERMINAL. Model ATL-008 employs an 8-MHz, 16-bit MC68008 μ P and features a tilt-and-swivel 14-in. display screen and detachable DIN-profile keyboard. It comes with 32k bytes of RAM (expandable to 128k) and 512 bytes of nonvolatile RAM



(expandable to 2k). The keyboard includes eight soft, 16 programmed and eight user-defined function keys. Other features include advanced editing capability, covering fixed and variable tab stops, programmable editing extents, comprehensive insert/delete capabilities, erase commands and logical attributes. A 256-character display provides 27 rows of 80 or 132 columns. Compatible with ANSI X3.64, the terminal allows asynchronous

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Sensitive RD controls operate from DC signals as low as 10 micro Amp.

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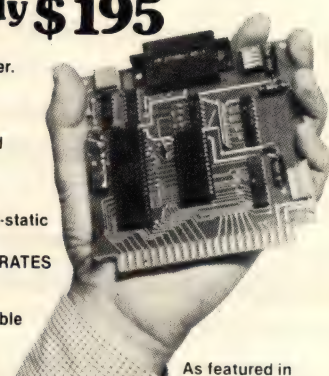
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advanced logic analysis



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LOGIC INSTRUMENTS

Circle 112 for more information

Circle 192 for demonstration

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DESIGN IN DIALIGHT

Computers & Peripherals

and isochronous operation at data rates to 19,200 baud. \$1395. **Beehive International**, Box 25668, Salt Lake City, UT 84125. Phone (801) 355-6000.

Circle No 267

COLOR-GRAPHICS SYSTEM.

Phoenix 1024 provides a 1024×1024-pixel viewable matrix with four or eight memory bit planes. It's pixel addressable and specs an 800-nsec pixel-writing speed with zoom magnification of 1:1 to 16:1. The unit incorporates an 8086 μ P and an 8087 floating-point math processor and uses CP/M-86 as its operating system. Communications occur via a host DMH interface through an RS-232C port that operates in an 8-bit (plus start & stop bit) asynchronous mode at 110 to 9600 baud. The unit uses SNA/327 protocol and provides 16M bytes of addressable memory with 128k of system RAM. Storage options include 1M-byte floppy disks and 10M- to 40M-byte Winchester. Languages include BASIC, FORTRAN and Pascal; software user functions range from pan, screen partition and character/vector/hardware zoom to graphics DMA, antialiasing mode and interactive mode. \$20,000 to \$30,000. Delivery, 30 to 45 days ARO. **Phoenix Computer Graphics Inc**, 1309 Pinhook Rd, Lafayette, LA 70503. Phone (318) 234-0063.

Circle No 268

TAPE DRIVES. Model 540-CT, a 45M-byte streaming 1/4-in. cartridge tape drive, allows front loading of a standard tape cartridge via sideways insertion. It installs using the same mounting holes and occupies the same dimensions as a 5 1/4-in. floppy- or rigid-disk drive. A second de-

DESIGN IN DIALIGHT ILLUMINATED SWITCHES



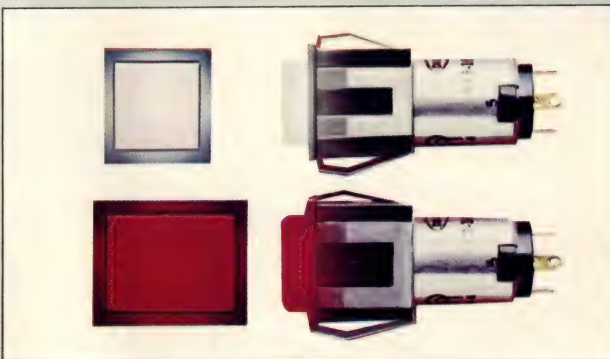
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CIRCLE NO 113

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The System 1200 family accommodates up to 22 half-quad or 11 full-quad cards to handle virtually any LSI-11 system. The System 2200 family holds 13 half-quad cards and the 3200 family is based on the low cost, compact 6 slot backplane with integral 8A supply. Important features common to all families are:

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Extend your system capability even further with the 2200CR and 3200CR monitor CRT units. These unique mountable displays are ideal for on-site monitoring in industrial and scientific installations as well as other applications. Limited graphics for display of system variables is included. Detachable environment proof keyboards and full stroke are optional.

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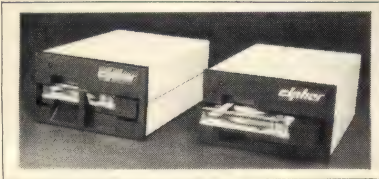
22 SLOTS
+5V@25A/40A

13 SLOTS
+5V@15A

6 SLOTS
+5V@8A

CIRCLE NO 114

Computers & Peripherals



vice, Model 440-CT, stores 45M bytes and furnishes an 8-in.-drive form factor. Both units spec an 87k-bytes/sec average data-transfer rate and a writing-burst rate of 200k bytes/sec. **Cipher Data Products Inc.**, Box 85170, San Diego, CA 92138. Phone (714) 578-9100.

Circle No 269

MODEM. Model 212 terminal-controlled modem features auto-dialing, menu-controlled options and operation, keyboard control of functions and diagnostics, and a nonvolatile memory. Users can dial numbers from the keyboard



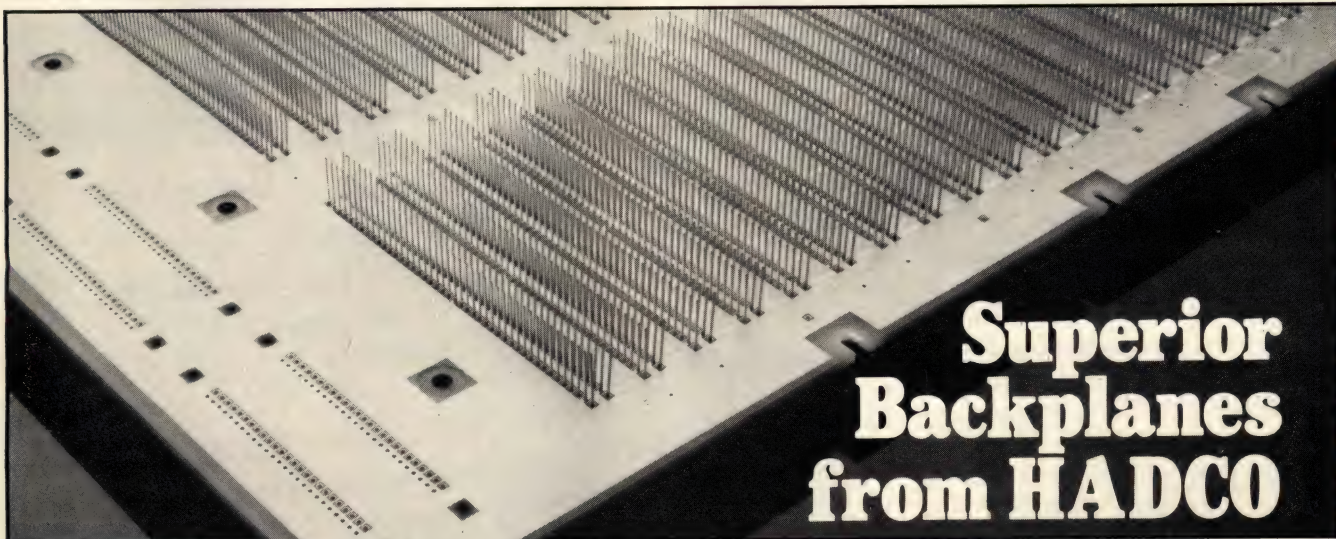
or from modem memory, eliminating the need for a phone; the unit also supports manual dialing and answering. Automatic detection of terminal speed eliminates manual speed setting. Bell 103 and 212 compatible, the device operates over 2-wire dial-up networks in full-duplex mode at asynchronous data rates of 0 to 300 and 1200 bps. \$795. **Prentice Corp.**, 266 Caspian Dr., Sunnyvale, CA 94086. Phone (408) 734-9810.

Circle No 270

COMPUTER SYSTEM. The Hawk-32 multiuser multitasking system provides as much as 1M

bytes of memory in an 18.9×17×10.5-in. 19-in.-rack-mounted package with as many as 16 RS-232C ports. A memory-management board allows the unit's 68000 μ P to run with no Wait states. Operating-system choices include UNIX Version 7 with Unisoft-adapted Berkeley enhancements or UNOS. Languages available under UNIX include Pascal, C, FORTRAN 77, COBOL and BASIC. Options include two 5¼-in., 20M-byte Winchester disk drives with a 5¼-in., 800k-byte floppy-disk drive or ¼-in., 20M/40M-byte streaming tape drive. With four terminals and a dot-matrix printer, \$18,000 (OEM qty). **CompuThink**, 965 W Maude Ave, Sunnyvale, CA 94086. Phone (408) 245-4033. TLX 172509.

Circle No 271



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For industrial environments, the 3B Series system provides a modular interface that directly connects to low-level sensor signals and produces simultaneous high-level voltage (0 to 10V, $\pm 10V$) and current (4 to 20 or 0 to 20 mA) outputs. Suiting process - control, factory-automation and data-acquisition measurement and control systems, the $3.15 \times 0.78 \times 3.4$ -in. plug-in modules can be mixed and matched on 4-, 8- and 16-channel backplanes. Operating over -25 to $+85^\circ\text{C}$, they spec 160-dB min CMR, $\pm 1500V$ isolation and 220V rms input protection. Input modules include units for isolated and nonisolated millivolt, volt, milliamp and 100Ω platinum RTDs; isolated J, K, T, E, R, S and B thermocouples; nonisolated strain gauges; and AD590 semiconductor temperature transducers. Output modules come in isolated and nonisolated versions. All modules are factory calibrated for $\pm 0.1\%$ typ accuracy and feature complete signal-conditioning functions, including input protection, filtering, chopper-stabilized low drift, RTD linearization and sensor excitation where required. A wide zero-suppression capability permits user mapping of any portion of the input signal to a full-scale output; a plug-in ranging card and user-supplied resistors define the zero and span of the range. Nonisolated and isolated modules, from \$135 and \$175, respectively; backplanes, \$120,

\$240 and \$345 for 4-, 8- and 16-channel versions, respectively. **Analog Devices Inc**, 2 Technology Way, Norwood, MA 02062. Phone (617) 329-4700.

Circle No 250

SINGLE-BOARD COMPUTER.

Based on the Oki 80C85 μP , the CPU-8085 features 22 programmable I/O lines, 2k of RAM and 2k of EPROM, a fully buffered bus, a 3-MHz clock rate and an on-board voltage regulator for direct connection to battery or unregulated supplies. The C-44-bus-compatible board also comes with an 81C55 port chip with timer, 2k of low-power 6116 RAM and a 27C16 EPROM loaded with a monitor program; it uses 4k of address space and 16 port spaces. The on-board switching regulator can be connected to any dc input $>8V$ and $<18V$; its maximum current capacity specs at >100 mA. A Hibernate mode reduces board current drain to about 2.5 mA from an 8V input or 1.5 mA with 18V. \$250. **Synapse Corp**, Box 1016, North Falmouth, MA 02556. Phone (617) 563-2267.

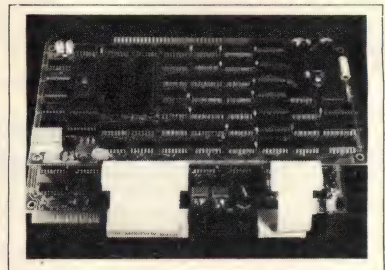
Circle No 251



MEMORY CONTROLLER. An intelligent Multibus-compatible device, the Rimfire 15 handles as many as eight ANSI Winchester disk drives and as many as four 3M HCD 75 $\frac{1}{4}$ -in. cartridge-tape drives. It features DMA operation with 24-bit addressing and a separate 32-bit ECC word

on each sector ID and data block. Programmable for 8- or 16-bit systems, the unit executes commands in six categories: disk- and tape-drive control, disk- and tape-drive transfer, dump/restore and specials. With disk-data transfer, a simple command transfers as much as 64k sectors of data between the system memory and disk. Each sector is buffered on board. The controller's parameter-block interface provides programmable options, including bus lock, linked commands and interrupts. \$1450 (25). **Computer Products Corp**, 2405 Annapolis Lane, Plymouth, MN 55441. Phone (612) 559-2034.

Circle No 252



VIDEO PREPROCESSOR.

Configurable as a 2-, 3- or 4-board set, the 7-MHz intelligent Pixelcaster consists of the PDC-8100 digital controller and PVD-8000 video - interface board. Options include the PVE-8800 video - expansion board and the PME-8502 memory-expansion board. The unit interfaces via RS-232, accepts ASCII commands and features a Z80A CPU and a high-speed memory for storage of as many as 1024 image samples and coordinates of sample locations. Sample timing is referenced to the NTSC 3.579545-MHz color subcarrier. The 1024 4-bit pixels can each come from anywhere in the TV signal, including the sync intervals or even consecutive fields. The order of the pixel

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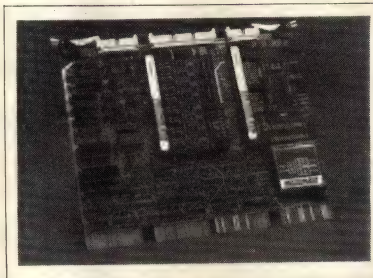
transmitted to the host is independent of the order in which the samples are acquired during the TV raster scan. PDC-8100, PVD-8000 and PVE-8800, \$790 each; PME-8052, \$650. **Vision Peripherals**, 2612 W Lincoln Ave, Suite 301, Anaheim, CA 92801. Phone (714) 952-1176.

Circle No 253

CPU BOARD. Based on the NS16032 μ P, this board furnishes full 32-bit architecture, 32-bit registers and data paths and a 16-bit data bus. Capable of accessing as much as 16M bytes of on-line system memory without segmentation, it features speeds to 10 MHz and on-board wait circuitry for generating zero to seven Wait states to accommodate slower peripherals. Pro-

visions are included for memory-management and floating-point units. Volume deliveries in 1st qtr 1983. **CompuPro Systems**, Oakland Airport, CA 94614. Phone (415) 562-0638.

Circle No 254



DATA-ACQUISITION BOARD. You can use the LSI-11-compatible DT3388 simultaneous-sample/hold board to sample as many as 12 high-level analog input channels, freeze their values within a ± 5 -nsec

aperture uncertainty and continuously transfer the data to disk files at rates to 90,000 samples/sec. Supported by CPLIB software, the quad-height board furnishes a 12-bit 100-kHz A/D converter and control and bus-interface logic. Analog ranges span 0 to 10V or ± 10 V (jumper selectable), with unity input gain. S/H aperture delay specs at < 100 nsec; droop rate equals 0.5 mV/msec. An on-board user-programmable RAM channel list permits user specification of the channels to be scanned. 4-channel version, \$2795; 12-channel version, \$3295. **Data Translation**, 100 Locke Dr, Marlboro, MA 01752. Phone (617) 481-3700.

Circle No 255

PROGRAMMABLE CONTROLLER. A dual-language controller for industrial automation, Model CP73P executes a control program written in Tiny BASIC or in the Process State Monitor (PSM) high-level interpretive language. Capable of making calls to BASIC subroutines, PSM allows user definition of a control process using a set of state diagrams, eliminating the need to create a ladder diagram. PSM 1.2 accommodates eight concurrent process sequences with as many as 99 states per process and runs five to 30 times faster than BASIC alone, according to the manufacturer. The controller has access to 26 16-bit variables that can be used as counters, eight 0.01-sec-resolution timers with a 10-min range and 48 industrial I/O channels. It mounts in the modular Powr-Trak industrial frame and is compatible with other Powr-Trak industrial-function cards. \$625. **Adatek Inc**, Box 1339, Sandpoint, ID 83864. Phone (800) 323-3343.

Circle No 256

HOW MANY PRODUCTION CONTROL APPLICATIONS ARE THERE FOR TERMIFLEX[®] HAND-HELD CONTROL/DISPLAY UNITS?

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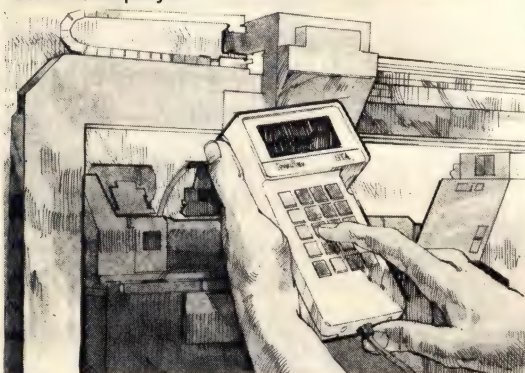
You'll find TERMIFLEX Hand-Held Displays controlling test and measurement equipment, at factory floor control stations, in maintenance operations, in production and in vehicle training and testing, in aircraft simulation control ... in fact wherever the need is for human interface to the system which is being controlled. Termiflex units are tough, compact and provide full control panel functions and operator prompting.

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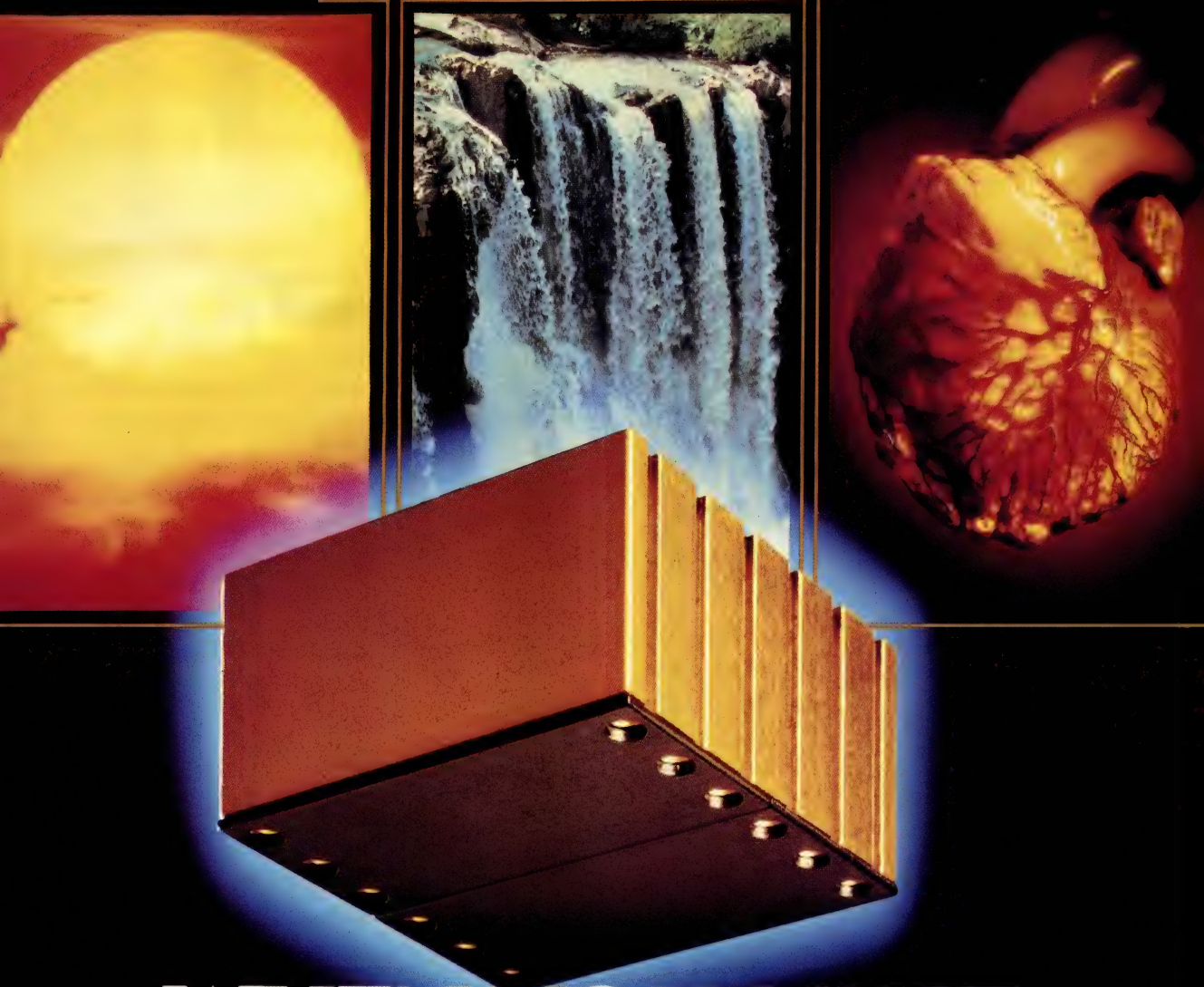


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CIRCLE NO 117



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You can use this electronic-mail software to send a message anywhere in the US and Canada for as little as \$0.20, according to the developer. Suiting communication among 10 or more of the supplier's computers, including the Z100 Series, ZGRAM uses GTE's Telemail service and features administrative control, unattended operation, automatic retrieval of transmission, transaction logs, multiple-telephone-line access, data encryption, error checking, and acknowledgement and reply features. The minimum configuration requires a μ C with at least 64k of memory, two disk drives with at least 800k of total storage, a smart modem, operating-system software and the Magic Wand word-processing package. Written in COBOL and assembly language, the package comes on 5¼- or 8-in. diskettes for a 1-time license fee of \$10,000. **Zenith Data Systems**, 1000 Milwaukee Ave, Glenview, IL 60025. Phone (312) 391-8181.

Circle No 279

MENU DIRECTORY. A menu-directory module for 8-bit- μ C systems, MDM 1.0 permits μ P system designers to catalog and access all applications software running on their systems. Providing a user-friendly software interface between a system and a CRT terminal, the package acts as an operating system to create a standardized, menu-formatted screen image that can be printed out using a self-documenting feature. The display is divided into three sections. The title section at the top of the screen shows the titles of the current menu and as many as three menu levels above it. The item section in the center of the screen contains as many as

10 keystroke-selectable items; additional 10-item pages are easily created. The control section at the bottom of the screen contains operating instructions. The software comes with instructions for implementing interfaces to CRTs and printers, flowcharts for all 38 subroutines, memory maps and an annotated 4k-byte source-code program listing. \$750. **Pro-Log Corp**, 2411 Garden Rd, Monterey, CA 93940. Phone (408) 372-4593. TWX 910-360-7082.

Circle No 280

ADA COMPILER. Part of its developer's Programming Support Environment (PSE), this Ada compiler runs on the Hewlett-Packard 9836 computer. It is implemented on that computer by an MC68000 native-code translator, which converts Ada-compiler-generated intermediate code into MC68000 native code for direct execution. Minimum hardware required to run the Ada package, in addition to the HP computer, includes 512k bytes of memory, two 98628A datacomm interface cards, a 9134A or 9135A hard-disk drive and the 98625 hard-disk interface. The HP Kit consists of the Hewlett-Packard run-time kernel (including HPROS); the developer's operating system (ROS); standard and advanced development utilities; a screen-oriented editor; the Ada compiler, including Ada text and structured I/O packages; an operating-system function package; a run-time support package; the MC68000 native-code translator; and system documentation. HP Kit, \$3360. **TeleSoft**, 10639 Roselle St, San Diego, CA 92121. Phone (714) 457-2700.

Circle No 281

CROSS ASSEMBLER. Producing object code for most 8-bit CPUs, CROSS80 provides a macro facility that allows user modification of the assembler's default Z80 instruction set or the definition of another 8-bit processor's instruction set. Macro libraries accommodate the 8080, 8085, 8048, 8051, 6800 and other widely used 8-bit μ Ps. The assembler's output consists of an object file in Intel hexadecimal format as well as listing and error reports. The software also furnishes a tool to downline-load the hex output to a PROM-programming system via an asynchronous line. The package runs on all Prime Computer 50, 400 and 500 Series systems. \$2500, including documentation, macro libraries and PROM-programming system. **Primarily Software Inc**, 1227 Pearl St, La Jolla, CA 92037. Phone (714) 454-0506.

Circle No 282

TERMINAL EMULATOR. The first in a series of terminal emulators based on the IBM Personal Computer, the multi-tasking TES-1 system permits users to exploit all the features of the IBM machine while exchanging information with a network host computer. Emulating the Texas Instruments Model 763 bubble-memory terminal, the package permits users to replace the TI terminals with the IBM computer without changing the host-computer software. Running under Concurrent CP/M-86, the software allows users to transmit and receive information, prepare messages and concurrently run other application programs. **Computer Distributors Inc**, 2603 W 22nd St, Suite 24, Oak Brook, IL 60521. Phone (312) 325-2430.

Circle No 283

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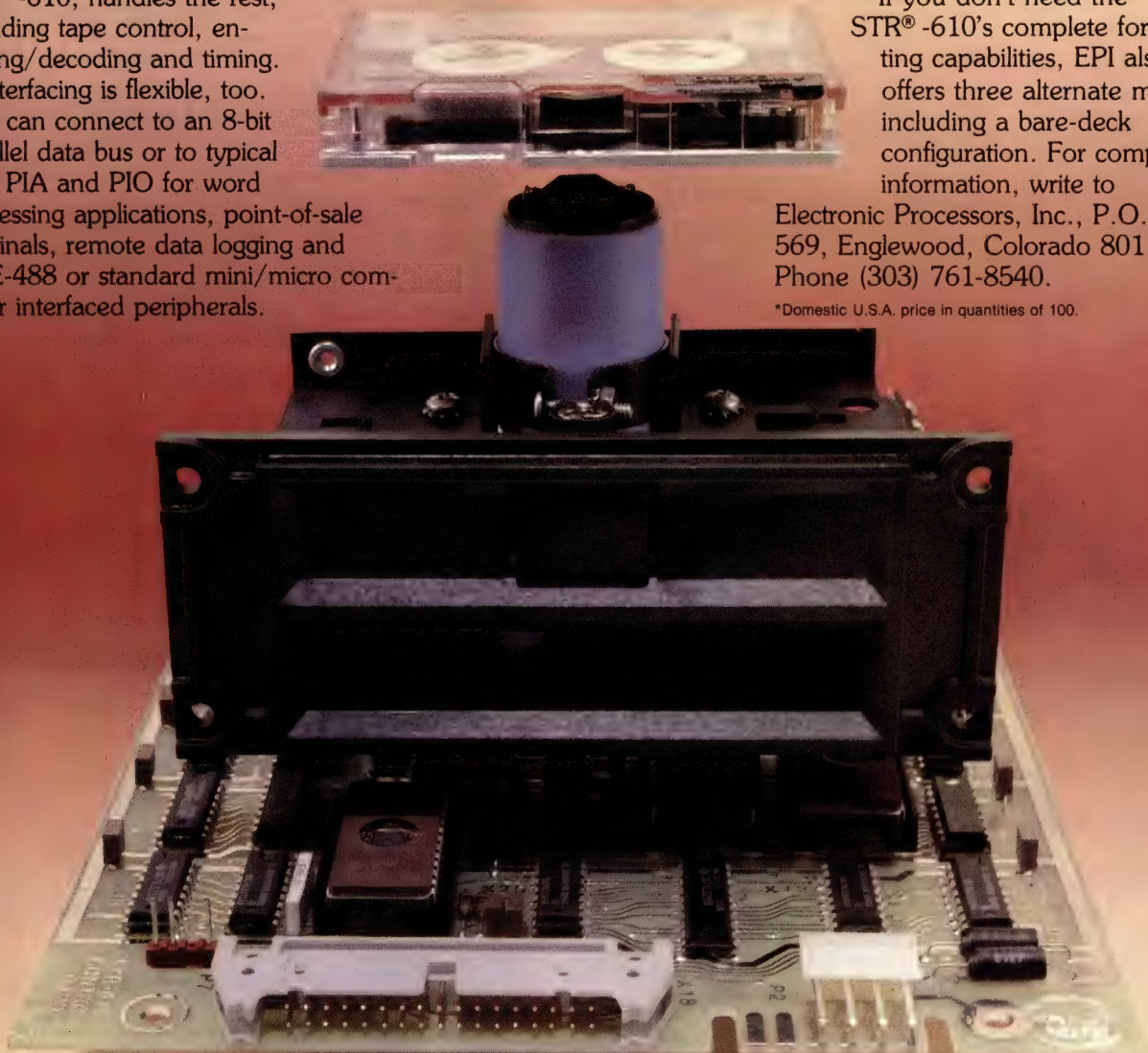
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RCA

Software

CAD PACKAGE. Running on the IBM Personal Computer, PAL_CAD is a computer-aided-design package for Monolithic Memories's programmable-array-logic (PAL) devices. Based on the PALASM software package, it assembles the PAL design specification, translating logic equations to PAL fuse patterns. It then executes a simulation that exercises function-table vectors using the logic equations and reports as errors any inconsistencies between the vectors and the equations. Finally, it prints a pinout of the PAL device. A display depicts PAL type and pin numbers with signal names. The package also prints a fuse-plot diagram, showing blown fuses and those still available for programming, and generates hexadecimal or binary programming-format files. Four standard formats for PROM programmers are provided; output goes to a disk file, permitting users to incorporate their own PROM-programmer interface codes. \$495. **Force Technology Corp.**, Box 20955, San Jose, CA 95160. Phone (408) 268-3359.

Circle No 284

SIMULATORS / DEBUGGERS.

This line of software simulators tests μ P applications using PDP-11 computers. Initial support is provided for 8080/8085, 8086/8088 and Z80 μ Ps. The software can be used with cross assemblers and cross compilers to identify and correct program-design and logic errors. Each simulator furnishes a complete simulation of all μ P features, including instruction execution, hardware registers, memory, I/O and interrupts. It also provides for loading of Intel hexadecimal files into simulated memory and features program execution

under breakpoint control, display and modification of registers and memory, Trace-mode operation for a detailed execution history, cycle count that indicates real-time execution speeds and interactive program assembly/disassembly. Support for symbolic debugging and relocatable

values is included. From \$1400 for a perpetual license, two sets of reference manuals and a software-maintenance/update service. **Virtual Systems Inc.**, 1500 Newell Ave, Suite 406, Walnut Creek, CA 94596. Phone (415) 935-4944.

Circle No 285

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Software

PASCAL COMPILER. Starplex II Pascal, a high-level-language compiler for its manufacturer's Starplex II development systems, can generate code for 8085 and NSC800 μ Ps. Fully relocatable and linkable with the company's other Starplex II languages, the software gener-

ates native machine code rather than intermediate P code. Enhancements of ISO-standard Pascal include lexical extensions, explicit locator references, declare-statements syntax, declaration of arrays, empty blocks and procedures, DO case extensions and iterative DO. Other

features include predefined procedures and functions for run-time support, including I/O, dynamic-allocation, mathematical, string, manipulation and library-function routines. \$2500. **National Semiconductor Corp.**, 2900 Semiconductor Dr, Santa Clara, CA 95051. Phone (408) 721-5000. TWX 910-339-9240.

Circle No 286

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Circle No. 202 For Literature Only Circle No. 203 For Immediate Application

HARD-DISK OS. For Radio Shack TRS-80 Model II and Model 16 μ Cs, this CP/M 2.2 operating system uses 16k bytes of controller RAM and 2k bytes of CPU memory, leaving 62k bytes of RAM in the CPU for user processing. Flawed disk sectors, bad tracks and other problems are automatically detected and corrected, and either TRSDOS or CP/M can be booted up, affording access to application programs formatted for either operating system stored on different parts of the same hard disk. The system can also bootstrap directly from the rigid platter without floppy-disk intervention. \$279 for CP/M 2.2 plus the hard-disk adaptation and full documentation. **Aton International Inc.**, 260 Brooklyn Ave, San Jose, CA 95128. Phone (408) 554-9922.

Circle No 287

DATA-ANALYSIS SYSTEM.

Suiting a broad range of engineering, science and business applications, INDAS (integrated data analysis system) serves VAX/VMS systems. It provides database facilities, including sort, merge, update and join capability; a complete programming language; a matrix-manipulation language; and statistical-analysis procedures including the General Linear Model. The package's matrix-



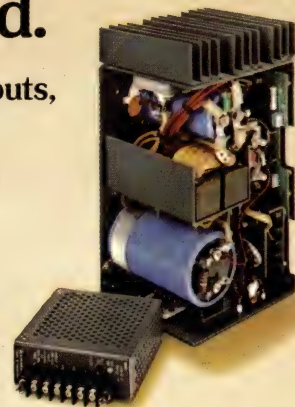
Every Lambda LU/LY Series power supply is tested, burned in, and re-tested.

LU/LY Series—13 triple, 4 dual, 59 single outputs, up to 28V, up to 120A, from \$47

NEW LYT-D—5V, up to 80A, $\pm 12V$, up to 6A, convection cooled.

1 Year Guarantee. 1 Day Delivery

△ LAMBDA ELECTRONICS
BETTER IN THE LONG RUN.



LY series switching power supplies solve design problems of size, heat and power.

Lambda's low-cost, open-frame switching power supplies are ideal for such OEM applications as computer peripherals, business machines and medical instrumentation where heat and size are critical. Compared to equivalent linear power supplies, they are typically one-quarter the size, have one-half the heat dissipation and have twice the output power.

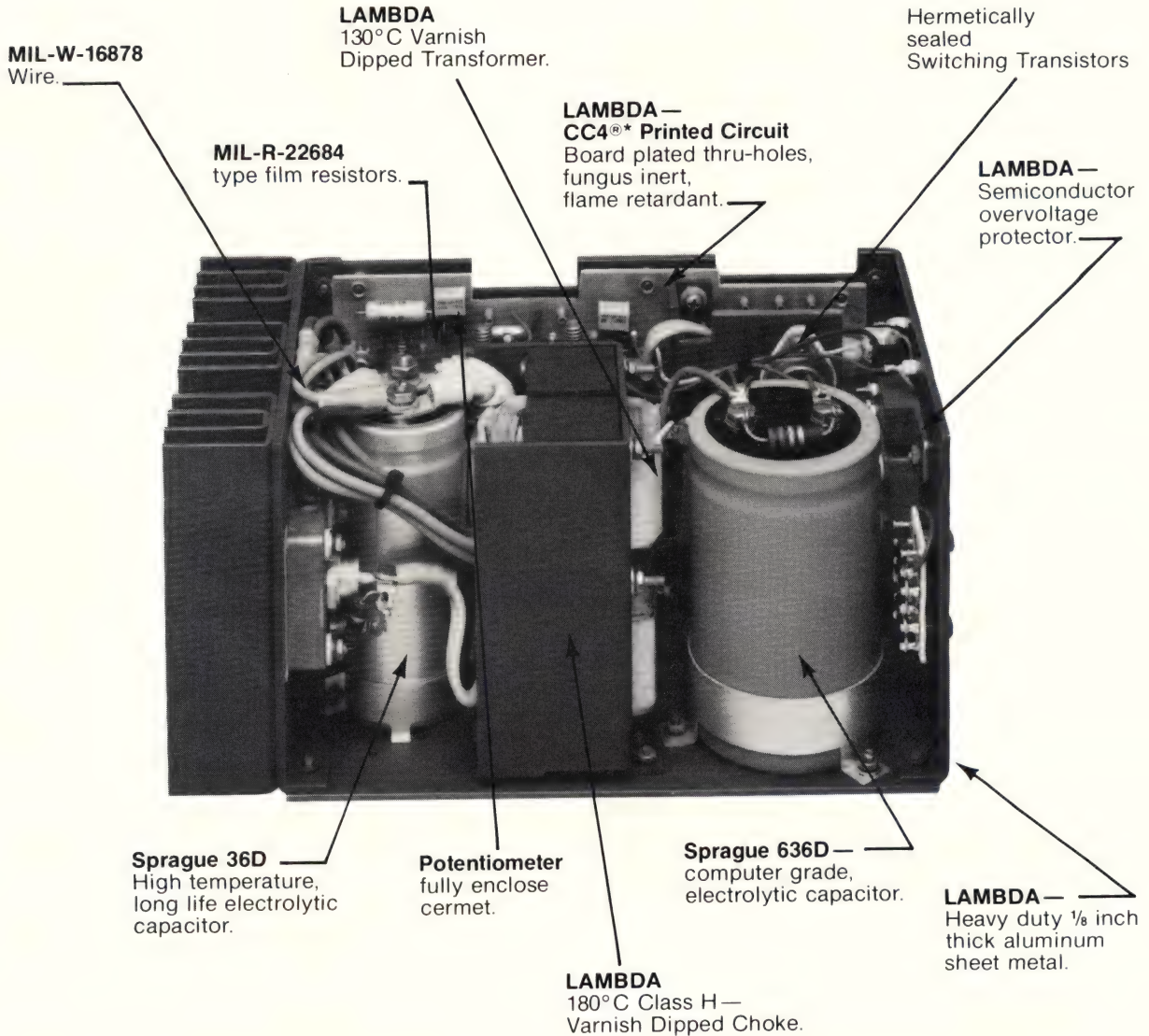
NEW triple output LYT-D models, which measure 7½" X 2½" X 14½", with outputs of 5V up to 80A, ±12V or ±15V, up to 6A, are the only power supplies of their size and power that do not require fans or blowers for cooling.

Forty-two single output, four dual output and ten triple output models are available. The triple output models feature regulation on all three outputs.

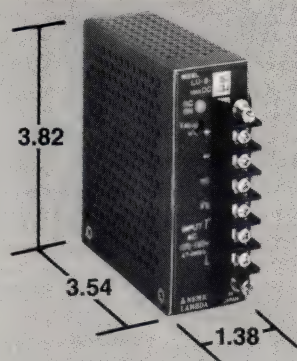
EMI suppression covers are available as accessories for all models. The covers provide additional filtering sufficient for compliance with FCC Docket 20780, CLASS A conducted. (See page 7.)

LY units are Underwriters Laboratories recognized and are CSA certified. (LYS-D, LYT-D presently under test.) VDE under evaluation.

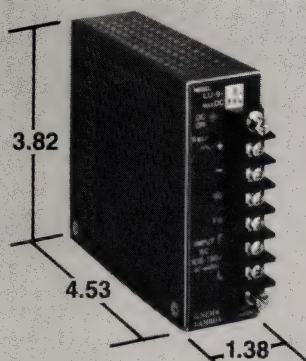
Lambda is its own distributor and all LY Series power supplies are available for one-day delivery from stock.



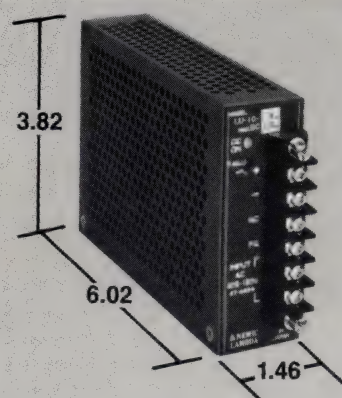
*Licensee of Photocircuits Inc.



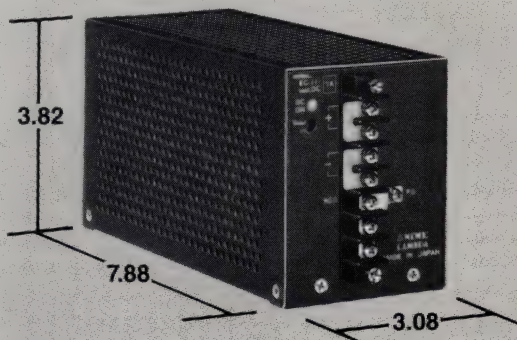
LU-8 package
up to 24V/up to 3A



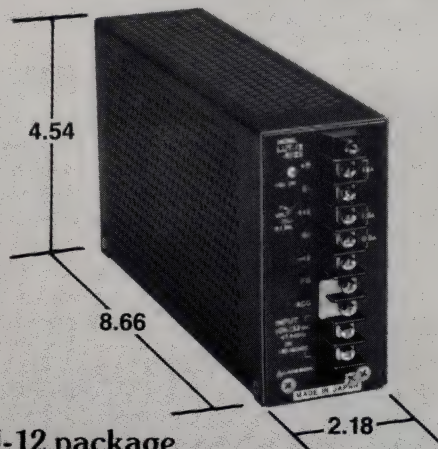
LU-9 package
up to 24V/up to 5A



LU-10 package
up to 24V/up to 10A



LU-11 package up to 28V/up to 20A



LU-12 package
3 triple output models

Lambda LU series switching power supplies: a versatile approach to multiple-output power supply systems.

The Lambda LU series now allows you the choice of single or multiple output units to meet your multiple-output power supply system requirements. You can build a truly modular system using single output models. But if your requirements fall within the range of one of Lambda's new LUT triple output models, you can take advantage of the space-savings of a single package...or you can combine single and triple output models to meet your specific needs.

What's more, LU series switching power supplies are $\frac{1}{3}$ smaller and lighter than linears. They have a cover, LED indicator and terminal strip. And they cost less. With prices starting at \$47 each, they are the world's least expensive switching power supplies.

When you consider all this, plus Lambda's traditional quality and reliability, it's no wonder the LU series is revolutionizing power system design.

Design your multiple output power supply combinations of voltage and currents from:

5V, 3A to 20A; 12V, 1.3A to 8.5A;

15V, 1.0A to 7A; 24V, 0.6A to 4.5A; 28V, 3.6A

...or see if one of our triple output power supplies meets your voltage output requirement.

Achieve the price and flexibility of low cost custom power supplies and still obtain the benefits of off-the-shelf standard modular power supplies—Delivery, Flexibility and Reliability.

LU units are Underwriters Laboratories recognized and are CSA certified.

LU SERIES VOLTAGE AND CURRENT RATINGS

MODEL	VOLT Vo	REGULATION (LINE, LOAD)	RIPPLE (mV RMS)	MAX CURRENT (AMPS AT)		PKG. SIZE	DIMENSIONS (Inches)	QTY. 1	PRICE	QTY. 1000
				40°C	50°C				QTY. 250	
TRIPLE OUTPUT MODELS										
5V ±5% ADJ. ±12V, -5V FIXED										
LUT-12-5125	+5	0.4%, 0.85%	15	12.0	9.6	12	4.54 x 2.18 x 8.66	\$190	\$152	\$142.50
	+12	0.4%, 1.0 %	15	1.5	1.2					
	-5	0.4%, 2.0 %	15	0.5	0.4					
5V ±5% ADJ. ±12V FIXED										
LUT-12-5122	+5	0.4%, 0.85%	15	12.0	9.6	12	4.54 x 2.18 x 8.66	190	152	142.50
	+12	0.4%, 1.0 %	15	1.5	1.2					
	-12	0.4%, 2.0 %	15	0.5	0.4					
5V ±5% ADJ. ±15V FIXED										
LUT-12-5152	+5	0.4%, 0.85%	15	12.0	9.6	12	4.54 x 2.18 x 8.66	190	152	142.50
	+15	0.4%, 1.0 %	15	1.5	1.2					
	-15	0.4%, 2.0 %	15	0.5	0.4					
SINGLE OUTPUT MODELS										
5V ±5% ADJ.										
LUS-8-5		0.4%, 0.85%	15	3.0	2.1	8	3.82 x 1.38 x 3.54	47	37.50	35.00
LUS-9-5		0.4%, 0.85%	15	5.0	3.5	9	3.82 x 1.38 x 4.53	72	57.50	54.00
LUS-10-5		0.4%, 0.85%	15	10.0	7.0	10	3.82 x 1.46 x 6.02	98	78.00	73.50
LUS-11-5		0.4%, 0.85%	15	20.0	14.0	11	3.82 x 3.08 x 7.88	139	111.00	104.00
12V ±5% ADJ.										
LUS-8-12		0.4%, 0.85%	15	1.3	0.9	8	3.82 x 1.38 x 3.54	47	37.50	35.00
LUS-9-12		0.4%, 0.85%	15	2.1	1.5	9	3.82 x 1.38 x 4.53	72	57.50	54.00
LUS-10-12		0.4%, 0.85%	15	4.2	2.9	10	3.82 x 1.46 x 6.02	98	78.00	73.50
LUS-11-12		0.4%, 0.85%	15	8.5	6.0	11	3.82 x 3.08 x 7.88	139	111.00	104.00
15V ±5% ADJ.										
LUS-8-15		0.4%, 0.85%	15	1.0	0.7	8	3.82 x 1.38 x 3.54	47	37.50	35.00
LUS-9-15		0.4%, 0.85%	15	1.7	1.2	9	3.82 x 1.38 x 4.53	72	57.50	54.00
LUS-10-15		0.4%, 0.85%	15	3.4	2.4	10	3.82 x 1.46 x 6.02	98	78.00	73.50
LUS-11-15		0.4%, 0.85%	15	7.0	4.9	11	3.82 x 3.08 x 7.88	139	111.00	104.00
24V ±5% ADJ.										
LUS-8-24		0.4%, 0.85%	15	0.6	0.4	8	3.82 x 1.38 x 3.54	47	37.50	35.00
LUS-9-24		0.4%, 0.85%	15	1.0	0.7	9	3.82 x 1.38 x 4.53	72	57.50	54.00
LUS-10-24		0.4%, 0.85%	15	2.1	1.5	10	3.82 x 1.46 x 6.02	98	78.00	73.50
LUS-11-24		0.4%, 0.85%	15	4.5	3.2	11	3.82 x 3.08 x 7.88	139	111.00	104.00
28V ±5% ADJ.										
LUS-11-28		0.4%, 0.85%	15	3.6	2.5	11	3.82 x 3.08 x 7.88	139	111.00	104.00

LY SERIES VOLTAGE AND CURRENT RATINGS. TRIPLE OUTPUT.

MODEL	VOLT Vo	REGULATION (LINE, LOAD)	RIPPLE (mV RMS)	MAX CURRENT (AMPS AT)			PKG. SIZE	DIMENSIONS (Inches)	QTY. 1	PRICE	QTY. 1000
				40° C	50° C	60° C				QTY. 250	
5 ± 5% ADJ. ± 12V ⁽³⁾											
LYT-X-5122	5	0.1%, 0.1%	10	7.5	6.6	5.7	X	7 x 4-7/8 x 2-3/4	\$230	\$196	\$173
	± 12 ⁽³⁾	0.1%, 100 mV	15	0.9	0.8	0.7					
LYT-W-5122	5	0.1%, 0.1%	10	14.0	12.7	11.0	W	9 x 4-7/8 x 2-3/4	290	246	218
	± 12 ⁽³⁾	0.1%, 100 mV	15	1.2	1.1	0.9					
LYT-P-5122	5	0.1%, 0.1%	10	28.0	24.5	20.0	P	10 x 4-7/8 x 4-7/16	410	349	308
	± 12 ⁽³⁾	0.1%, 100 mV	15	3.0	2.6	2.2					
LYT-K-5122	5	0.1%, 0.1%	10	40.0	36.0	29.0	K	10 x 4-7/8 x 5-1/2	557	473	446
	± 12 ⁽³⁾	0.1%, 100 mV	15	4.0	3.5	2.9					
LYT-D-5122	+ 5	0.1%, 0.1%	10	74.0	67.0	50.0	D	7-1/2 x 9-1/2 x 14-13/16	650	553	520
	± 12 ⁽³⁾	0.1%, 100 mV	15	6.0	5.1	4.2					
5 ± 5% ADJ. ± 15V ⁽³⁾											
LYT-X-5152	5	0.1%, 0.1%	10	7.5	6.6	5.7	X	7 x 4-7/8 x 2-3/4	\$230	\$196	\$173
	± 15 ⁽³⁾	0.1%, 100 mV	15	0.8	0.7	0.6					
LYT-W-5152	5	0.1%, 0.1%	10	14.0	12.7	11.0	W	9 x 4-7/8 x 2-3/4	290	246	218
	± 15 ⁽³⁾	0.1%, 100 mV	15	1.2	1.1	.09					
LYT-P-5152	5	0.1%, 0.1%	10	25.0	22.0	18.0	P	10 x 4-7/8 x 4-7/16	410	349	308
	± 15 ⁽³⁾	0.1%, 100 mV	15	3.0	2.6	2.2					
LYT-K-5152	5	0.1%, 0.1%	10	37.0	33.0	27.0	K	10 x 4-7/8 x 5-1/2	557	473	446
	± 15 ⁽³⁾	0.1%, 100 mV	15	4.0	3.5	2.9					
LYT-D-5152	+ 5	0.1%, 0.1%	10	65.0	59.0	43.0	D	7-1/2 x 9-1/2 x 14-13/16	650	553	520
	± 15 ⁽³⁾	0.1%, 100 mV	15	6.0	5.1	4.2					

Other voltage and current ratings available on special order. Consult factory.

LY SERIES. DUAL OUTPUT.

±12V⁽³⁾										
LYD-Y-122	0.1%, 100 mV	15	1.8	1.5	1.2	Y	5-5/8 x 4-7/8 x 2-1/2	\$216	\$189	\$162
LYD-X-122	0.1%, 100 mV	15	3.0	2.5	2.0	X	7 x 4-7/8 x 2-3/4	263	224	198
±15V⁽³⁾										
LYD-Y-152	0.1%, 100 mV	15	1.8	1.5	1.2	Y	5-5/8 x 4-7/8 x 2-1/2	216	189	162
LYD-X-152	0.1%, 100 mV	15	3.0	2.5	2.0	X	7 x 4-7/8 x 2-3/4	263	224	198

LY SERIES. SINGLE OUTPUT.

MODEL	VOLT V _o	REGULATION (LINE, LOAD)	RIPPLE (mV RMS)	MAX CURRENT (AMPS AT)			PKG. SIZE	DIMENSIONS (Inches)	QTY. 1	PRICE QTY. 250	QTY. 1000
5 VOLTS ±5% ADJ.											
LYS-Y-5		0.1%, 0.1%	10	11.0	11.0	9.5	Y	5-5/8 x 4-7/8 x 2-1/2	\$178	\$151	\$133
LYS-X-5		0.1%, 0.1%	10	20.0	17.7	15.0	X	7 x 4-7/8 x 2-3/4	212	180	159
LYS-W-5		0.1%, 0.1%	10	35.0	31.5	27.5	W	9 x 4-7/8 x 2-3/4	260	221	195
LYS-P-5		0.1%, 0.1%	10	50.0	46.0	40.0	P	10 x 4-7/8 x 4-7/16	330	280	248
LYS-K-5-OV		0.1%, 0.1%	10	70.0	61.0	50.0	K	10 x 4-7/8 x 5-1/2	458	389	344
LYS-D-5-OV		0.1%, 0.1%	10	120.0	104.0	86.0	D	7-1/2 x 9-1/2 x 4-13/16	640	544	480
6 VOLTS ±5% ADJ.											
LYS-Y-6		0.1%, 0.1%	10	9.4	9.4	8.2	Y	5-5/8 x 4-7/8 x 2-1/2	178	151	133
LYS-X-6		0.1%, 0.1%	10	17.0	15.0	12.7	X	7 x 4-7/8 x 2-3/4	212	180	159
LYS-W-6		0.1%, 0.1%	10	30.0	27.5	24.0	W	9 x 4-7/8 x 2-3/4	260	221	195
LYS-P-6		0.1%, 0.1%	10	43.0	40.0	35.0	P	10 x 4-7/8 x 4-7/16	330	280	248
LYS-K-6-OV		0.1%, 0.1%	10	60.0	53.0	43.0	K	10 x 4-7/8 x 5-1/2	458	389	344
LYS-D-6-OV		0.1%, 0.1%	10	104.0	90.0	74.0	D	7-1/2 x 9-1/2 x 4-13/16	640	544	480
12 VOLTS ±5% ADJ.											
LYS-Y-12		0.1%, 0.1%	15	6.0	6.0	5.1	Y	5-5/8 x 4-7/8 x 2-1/2	178	151	133
LYS-X-12		0.1%, 0.1%	15	10.4	9.3	7.8	X	7 x 4-7/8 x 2-3/4	212	180	159
LYS-W-12		0.1%, 0.1%	15	20.0	18.0	15.0	W	9 x 4-7/8 x 2-3/4	260	221	195
LYS-P-12		0.1%, 0.1%	15	29.0	27.0	23.0	P	10 x 4-7/8 x 4-7/16	330	280	248
LYS-K-12		0.1%, 0.1%	15	40.0	35.0	29.0	K	10 x 4-7/8 x 5-1/2	430	366	323
LYS-D-12-OV		0.1%, 0.1%	15	57.0	50.0	41.0	D	7-1/2 x 9-1/2 x 4-13/16	640	544	480
15 VOLTS ±5% ADJ.											
LYS-Y-15		0.1%, 0.1%	15	5.0	5.0	4.3	Y	5-5/8 x 4-7/8 x 2-1/2	178	151	133
LYS-X-15		0.1%, 0.1%	15	8.5	7.5	6.3	X	7 x 4-7/8 x 2-3/4	212	180	159
LYS-W-15		0.1%, 0.1%	15	16.5	14.5	12.0	W	9 x 4-7/8 x 2-3/4	260	221	195
LYS-P-15		0.1%, 0.1%	15	24.0	22.0	19.0	P	10 x 4-7/8 x 4-7/16	330	280	248
LYS-K-15		0.1%, 0.1%	15	32.0	28.0	23.0	K	10 x 4-7/8 x 5-1/2	430	366	323
LYS-D-15-OV		0.1%, 0.1%	15	48.0	42.0	34.0	D	7-1/2 x 9-1/2 x 4-13/16	640	544	480
20 VOLTS ±5% ADJ.											
LYS-Y-20		0.1%, 0.1%	15	3.9	3.9	3.1	Y	5-5/8 x 4-7/8 x 2-1/2	178	151	133
LYS-X-20		0.1%, 0.1%	15	6.7	5.9	4.7	X	7 x 4-7/8 x 2-3/4	212	180	159
LYS-W-20		0.1%, 0.1%	15	12.5	11.5	9.5	W	9 x 4-7/8 x 2-3/4	260	221	195
LYS-P-20		0.1%, 0.1%	15	18.5	16.5	14.5	P	10 x 4-7/8 x 4-7/16	330	280	248
LYS-K-20		0.1%, 0.1%	15	25.0	21.5	18.0	K	10 x 4-7/8 x 5-1/2	430	366	323
LYS-D-20-OV		0.1%, 0.1%	15	36.0	31.5	26.0	D	7-1/2 x 9-1/2 x 4-13/16	640	544	480
24 VOLTS ±5% ADJ.											
LYS-Y-24		0.1%, 0.1%	15	3.3	3.3	2.6	Y	5-5/8 x 4-7/8 x 2-1/2	178	151	133
LYS-X-24		0.1%, 0.1%	15	5.7	4.9	4.0	X	7 x 4-7/8 x 2-3/4	212	180	159
LYS-W-24		0.1%, 0.1%	15	10.5	9.5	8.0	W	9 x 4-7/8 x 2-3/4	260	221	195
LYS-P-24		0.1%, 0.1%	15	15.5	14.0	12.0	P	10 x 4-7/8 x 4-7/16	330	280	248
LYS-K-24		0.1%, 0.1%	15	21.0	18.0	15.0	K	10 x 4-7/8 x 5-1/2	430	366	323
LYS-D-24-OV		0.1%, 0.1%	15	32.0	28.0	23.0	D	7-1/2 x 9-1/2 x 4-13/16	640	544	480
28 VOLTS ±5% ADJ.											
LYS-Y-28		0.1%, 0.1%	15	2.8	2.8	2.2	Y	5-5/8 x 4-7/8 x 2-1/2	178	151	133
LYS-X-28		0.1%, 0.1%	15	5.0	4.3	3.5	X	7 x 4-7/8 x 2-3/4	212	180	159
LYS-W-28		0.1%, 0.1%	15	9.5	8.5	7.0	W	9 x 4-7/8 x 2-3/4	260	221	195
LYS-P-28		0.1%, 0.1%	15	13.5	12.5	10.5	P	10 x 4-7/8 x 4-7/16	330	280	248
LYS-K-28		0.1%, 0.1%	15	18.0	15.5	13.0	K	10 x 4-7/8 x 5-1/2	430	366	323
LYS-D-28-OV		0.1%, 0.1%	15	27.5	24.0	19.5	D	7-1/2 x 9-1/2 x 4-13/16	640	544	480

NOTES: 1. Ratings are for LY series when cover not used. When cover is used derate by 10%.

2. Dimensions are without cover.

3. ± outputs are fixed and preset at factory to be within 100 mV of nominal and within 100 mV of each other at no load, 25° C ambient.

LY series specifications

DC Output

Voltage range shown in tables.

Regulated Voltage

regulation, line 0.1%
regulation, load 0.1% for single output models, and 5V
output of LYT, 100mV from 0 to full load for dual output models
and dual outputs of LYT
ripple and noise 10mV RMS, 75mV p-p for 5V and 6V models,
and 5V output of LYT, 15mV RMS, 150mV p-p for 12V through
28V models, 15mV RMS, 150mV p-p for dual output models, and
dual output of LYT
temperature
coefficient 0.03%/°C
remote programming
resistance 200 Ω /V (Not applicable to dual output
models or dual output of LYT)
remote programming
voltage volt per volt (not applicable to dual output
models or dual output of LYT)

AC Input

line 105 to 132 VAC, 47-440 Hz
power 105 to 132 VAC, 47-440 Hz
130 watts max for LYS-Y models, 200 watts max for LYS-X
models, 380 watts max for LYS-W models, 510 watts max for
LYS-P models, 700 watts for LYS-K models, 1150 watts for LYS-D
models, 105 watts max for LYD-Y models, 160 watts max for
LYD-X models, 125 watts max for LYT-X models, 190 watts
max for LYT-W models, 420 watts max for LYT-P models, 580 watts
for LYT-K models, 840 watts max for LYT-D models
efficiency 60% min for LYS-Y models, 64% min
LYS-X models, 64% min for LYS-W models, 67% min for LYS-P
models, 65% min for LYS-K&D models, 57% min for LYD-Y and
LYT-W models, 60% min for LYD-X models, 50% min for LYT-X
models, 52% min for LYT-P models and 55% min for LYT-K models,
58% min for LYT-D models
power failure
hold up time 5V and 6V models and the LYT & LYS-D
models will remain within regulation limits for at least 16.67 msec
after loss of AC power when operating at full load, V_{OUT} max and
minimum input at 60 Hz

DC Input 145VDC $\pm$ 10%

Overshoot

No overshoot at turn-on, turn-off, or power failure.

Ambient Operating Temperature

Continuous duty 0° to 60° with suitable derating shown in tables.

Storage Temperature Range

-55°C to +85°C

Overload Protection Electrical

External overload protection, automatic electronic current limiting
circuit limits the output current (short circuit output current LYT
only) to a preset value, thereby providing protection for the load as
well as the power supply.

Cooling

Convection cooled, no fans or blowers needed.

Soft Start

LYS-D and LYT-D models only, limits inrush current at turn on.

EMI

EMI suppression cover available as an accessory. Provides additional
filtering sufficient for compliance to FCC Docket #20780, Class A con-
ducted; perforated cover minimizes radiated emissions. Customer
input and output connections via barrier strips mounted on cover
(LYT-X, LYT-W, LYS-Y, LYS-X, LYS-W, LYD-Y, LYD-X models),
and terminal board mounted on cover of LYS-P, LYS-D, LYS-K, LYT-P
and LYS-K models. Output current must be derated 10% with cover,
15% for LYS-D with cover. Ripple and noise when cover is used is
10mV RMS, 35mV p-p for 5 and 6V units, 15mV RMS, 100mV p-p for
12 thru 28V units and duals. See page 7 for cover model and price
for each LY series.

DC Output Controls

Simple screwdriver voltage adjustment over the entire voltage range.
(Not applicable to dual output models or dual output of LYT.)

Mounting

Three mounting surfaces and three mounting positions. (One
mounting surface and one mounting position for LYS-P, LYS-K, LYS-D,
LYT-P, LYT-K, and LYT-D) models.

Input and Output Connections

Solder terminals located on printed circuit boards, (studs for LYS-X,
W, P, K and 5V output of LYT-W and LYT-P and LYT-K and heavy duty
studs for LYS-D and LYT-D). When EMI suppression cover is used con-
nections through barrier strips or terminal board mounted on cover.

Remote Sensing

Provision is made for remote sensing to eliminate the effects of
power output lead resistance on DC regulation. (Sum of dual outputs
can be remotely sensed on dual and triple models.)

PHYSICAL DATA

Package Model	Weight (without cover)		Size Inches
	Lbs. Net	Lbs. Ship	
LYS-Y	2-3/4	3	5-5/8 x 4-7/8 x 2-1/2 (w/o cover) 5-5/8 x 4-7/8 x 3-5/16 (w cover)
LYS-YV	2-3/4	3	6.5 x 4.33 x 2.5 (w/o cover)
LYD-Y	3-1/4	3-1/2	5-5/8 x 4-7/8 x 2-1/2 (w/o cover) 5-5/8 x 4-7/8 x 3-5/16 (w cover)
LYS-X, XV	4	4-1/2	7 x 4-7/8 x 2-3/4 (w/o cover) 7 x 4-7/8 x 3-5/16 (w cover)
LYD-X	4-1/4	4-3/4	7 x 4-7/8 x 2-3/4 (w/o cover) 7 x 4-7/8 x 3-5/16 (w cover)
LYT-X	4-1/4	4-3/4	7 x 4-7/8 x 2-3/4 (w/o cover) 7 x 4-7/8 x 3-5/32 (w cover)
LYS-W, WV	5-1/2	6	9 x 4-7/8 x 2-3/4 (w/o cover) 9 x 4-7/8 x 3-3/4 (w cover)
LYT-W, WV	6	6-1/2	9 x 4-7/8 x 2-3/4 (w/o cover) 9 x 4-7/8 x 4-5/32 (w cover)
LYS-P, PV	8-1/2	10-1/2	10 x 4-7/8 x 4-7/16 (w/o cover) 10 x 4-7/8 x 5-9/16 (w cover)
LYT-P, PV	9-3/4	12-1/2	10 x 4-7/8 x 4-7/16 (w/o cover) 10 x 4-7/8 x 5-5/8 (w cover)
LYS-K, KV	11	13-1/2	10 x 4-7/8 x 5-1/2 (w/o cover) 10 x 4-7/8 x 7-1/2 (w cover)
LYS-D	12-1/2	15-1/2	7-1/2 x 9-1/2 x 4-13/16 (w/o cover) 7-1/2 x 11 x 4-13/16 (w cover)
LYT-K	11	13-1/2	10 x 4-7/8 x 5-1/2 (w/o cover) 10 x 4-7/8 x 7-21/32 (w cover)
LYT-D	13	16	7-1/2 x 9-1/2 x 14-13/16 (w/o cover)

Options

AC Input

(LYS-Y, X, W, P, K; and LYT-W, P models only).

Add ⁽¹⁾ Suffix	For Operation at:	Price ⁽²⁾
-V	187-265 VAC 47-440 Hz	12% or \$30†

†Whichever is greater.

⁽¹⁾Add V after package number. (LYS-YV-5)

⁽²⁾Consult factory for voltage and current ratings and quantity prices.

Finish

Gray, Fed. Std. 595, No. 26081.

UL/CSA

UL recognized and CSA certified. (LYT-D under evaluation.)

Accessories

Overvoltage protection built in on LYS-D and LYS-K, 5V and 6V models,
LYT-K and LYT-D 5V output only. Available as accessory on other models—
see catalog. Rack adapters available; LRA-14 through LRA-17. Not all
models fit in LRA-14 and LRA-16, see catalog.
EMI suppression cover—see next page.

Guarantee for 1 Year

One year guarantee includes labor as well as parts.

LU series specifications

DC Output

Voltage range shown in tables.

Regulated Voltage

regulation, line 0.4%
regulation, load 0.85% single output models
(all outputs and main output of LUT-12
regulated on models, 1.0% second output,
LUT-12, no cross 2.0% third output of LUT-12
regulation) models (0 to full load, no pre-
load required).
ripple and noise. 15mV RMS all models;
200mV p-p for 12V and 15V
models, 250mV p-p for 24V
and 28V models. 120mV p-p
for main output of LUT-12
models, 150mV p-p for second
and third outputs.

temperature
coefficient 0.02%/°C (0.04%/°C for
second and third outputs of
LUT-12 models).

AC Input

line 105 to 132 VAC, 47-440 Hz
efficiency minimum . . . 62% for LUS-8 models,
66% for LUS-9 models,
72% for LUS-10 and LUS-11
models. 68% LUT-12-5125,
70% LUT-12-5152, 5122.

DC Input 130-160 VDC

Overshoot

No overshoot at turn-on, turn-off or power failure.

Ambient Operating Temperature

Continuous duty 0° to 50°C with suitable derating
shown in table on page 2.

Storage Temperature

−30°C to +85°C.

Overload Protection

External overload protection, automatic factory
preset electronic current limiting circuit limits the
output current thereby providing protection for the
load as well as the power supply. Internal failure
protection provided by fuse.

Overvoltage Protection

Overvoltage protection is standard on LUS-9, LUS-10,
LUS-11 and main output of LUT-12 models. For other
models and second and third outputs of LUT-12
models, see accessory pages in catalog.

Cooling

Convection cooled, no fans or blowers needed.

DC Output Controls

Simple screwdriver voltage adjustment over the
entire voltage range of single output models and
main output of LUT-12 models. Second and third
outputs of LUT-12 models are fixed.

Output Status Indicator

LED indicates presence of voltage on single output
models and on main output of LUT-12 models.

Mounting

One mounting surface, one mounting position.

Input and Output Connections

Heavy duty terminal block on front of chassis.

Physical Data

Package Model	Weight (lbs.)		Size Inches*
	Net	Ship	
LUS-8	0.62	0.75	3.82 x 1.38 x 3.54
LUS-9	0.78	1.00	3.82 x 1.38 x 4.53
LUS-10	1.04	1.25	3.82 x 1.46 x 6.02
LUS-11	2.43	2.99	3.82 x 3.08 x 7.88
LUT-12	2.00	2.45	4.54 x 2.18 x 8.66

*Excluding terminal block

Finish

Gray, Fed. Std. 595, No. 26081.

Accessories

Overvoltage protectors available—see catalog.
(Built-in LUS-9, LUS-10, LUS-11 and main output
of LUT-12 models.)

Guarantee

1 year guarantee includes labor as well as parts.
Guarantee applies to operation at full published
specifications at end of 1 year.

■ -Recognized

CSA—Listed (LUS-11 and LUT-12 under evaluation).
VDE under evaluation.

LY series EMI suppressor accessory

EMI suppression cover available as an accessory.
Provides additional filtering sufficient for com-
pliance with FCC Docket 20780, Class A con-
ducted; perforated cover minimizes radiated
emissions. Customer input and output connec-
tions via barrier strips mounted on cover. (LYS-Y,
LYS-X, LYS-W, LYD-Y, LYD-X, LYT-P, LYT-W,
LYT-X models), and terminal board mounted on
cover for LYS-P, LYS-D, LYT-K and LYS-K models.
Ripple and noise when cover is used is 10mVRMS,
35mV p-p for 5 and 6V units. 15mV RMS, 100mV p-p
for 12 thru 28V units and duals.



Cover Model	For Use With	Weight		Price
		Lbs. Net	Lbs. Ship	
M-YDY-2	LYD-Y models	1-1/2	1-3/4	\$ 60
M-YDX-2	LYD-X models	1-3/4	2	69
M-YSD-2	LYS-D models	2-1/4	3-1/4	151
M-YSK-2	LYS-K models	3-3/4	5	114
M-YSP-2	LYS-P models	2-1/8	3-1/4	84
M-YSW-2	LYS-W models	2	2-1/4	78
M-YSX-2	LYS-X models	1-3/4	2	60
M-YSY-2	LYS-Y models	1-1/2	1-3/4	60
M-YTK-2	LYT-K models	3	4	144
M-YTP-2	LYT-P models	2-7/8	3-1/2	109
M-YTW-2	LYT-W models	2	2-1/4	75
M-YTX-2	LYT-X models	1-3/4	2	75

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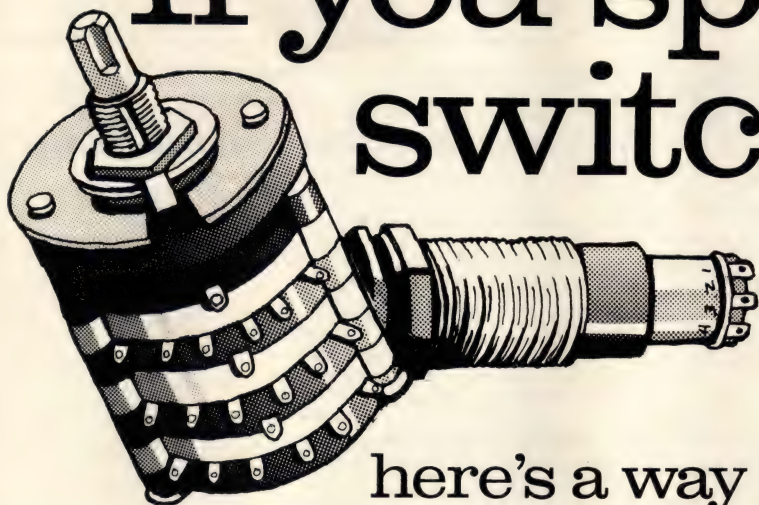
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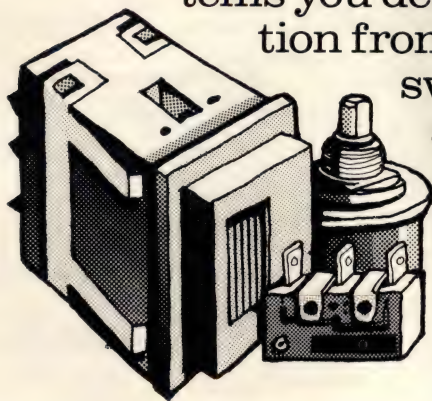
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LOGIC SIMULATOR. Aimed at design-verification and test-generation applications for complex VLSI ICs, CADAT (computer-aided design and test) is written in the C language and runs on DEC VAX computers under VMS or Bell Labs's UNIX operating systems. Combining design and fault-simulation capabilities, it provides simulation support for chip development from initial design stages through the generation of a manufacturing test and permits recycling of design-simulation data for test generation once a design is complete. Nine-state simulation accurately mirrors the behavior of bipolar and MOS technologies; transmission-gate models and a wired-bus element allow the software to model MOS circuits' bidirectional signal flow. The software furnishes

10-psec timing resolution; you can set independent rise and fall delay times for each device output. Input is entered in English-language specifications that support macro and vector-manipulation capabilities. Fault-trace capability, a batch-processing mode and a random fault-sampling feature are provided. **Softron Inc.**, 116 Rte 17 North, Upper Saddle River, NJ 07458. Phone (201) 327-8014.

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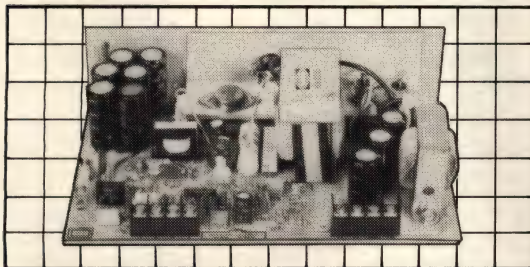
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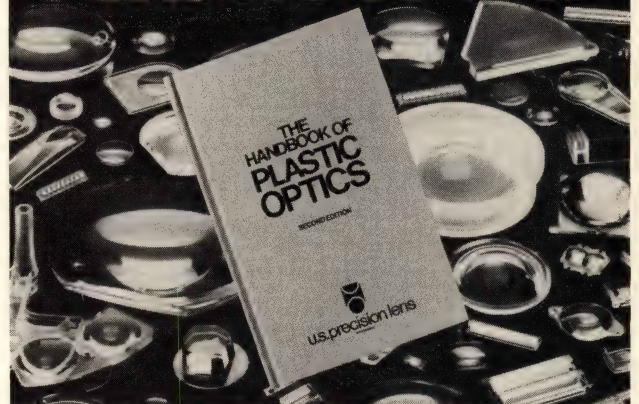
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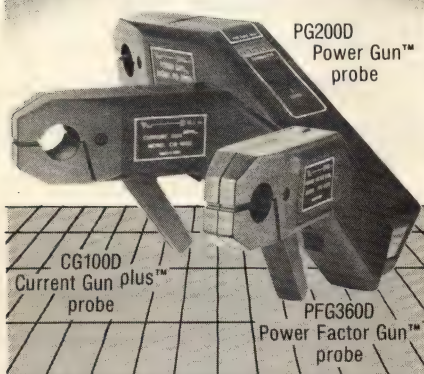
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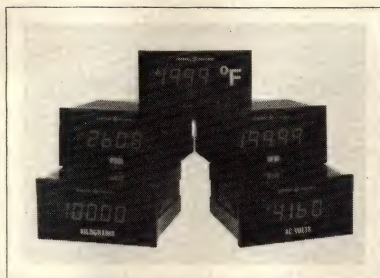
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Circle No 272

DATA-LINE TEST SET. You can use Model 809B to troubleshoot and qualify voice-frequency data-transmission circuits. As a stand-alone unit or part of a test

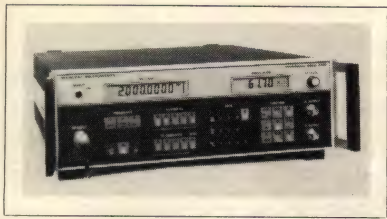
system, the instrument provides more than 17 key tests, can be programmed with frequently used test values, furnishes stored and programmable circuit-conditioning specifications and provides operator prompts. Operating in manual or remote mode and using a GPIB or RS-232C interface, the portable unit measures transmission impairments in accordance with BSTR 41009. \$10,950. **Lear Siegler Inc., Sierra Electronic Div.**, 3885 Bohannon Dr, Menlo Park, CA 94025. Phone (415) 321-5374.

Circle No 273



TEST INTERFACE/FIXTURE. The pneumatically operated OB 6000 receiver provides 6120-test-point capacity with discrete wiring or 5760 points utilizing a 32-pin ribbon-cable interface. Usable with virtually any ATE system, it comes with a choice of three cam-locking vacuum test heads capable of accommodating loaded- or bare-board testing requirements. The cam-locking interface can also be adapted to manual and pneumatic test heads for specialized applications. Other features include built-in strain relief for base-receiver wiring and removable covers for bare-board testing. Base receivers, from \$1995 plus \$1 per point; test heads, from \$350. **Ostby & Barton Co.**, 487 Jefferson Blvd, Warwick, RI 02886. Phone (401) 739-7310.

Circle No 274



MODULATION METER. The 2-GHz Model 2305 combines the functions of a conventional modulation meter, RF power meter, frequency counter and audio analyzer in one package. Tuning can be performed automatically to the strongest input signal with a typical acquisition time of 500 msec. For tuning where several strong signals are present, the instrument can be pretuned to a frequency entered via the numerical keypad or GPIB. The 8-digit frequency display indicates the input's carrier frequency, the frequency error from a previously entered

value or the modulation frequency. The instrument can measure FM deviation to 500 kHz, phase deviation to 500 radians and AM depths to 99.9% with modulating frequencies to 300 kHz (50 kHz for AM). Other features include average-peak response, direct measurement of SINAD or distortion, RF power measurements from 10 mW to 1W and internal calibration. \$7500. Delivery, 60 days ARO. **Marconi Instruments**, 100 Stonehurst Ct, Northvale, NJ 07647. Phone (201) 767-7250.

Circle No 275

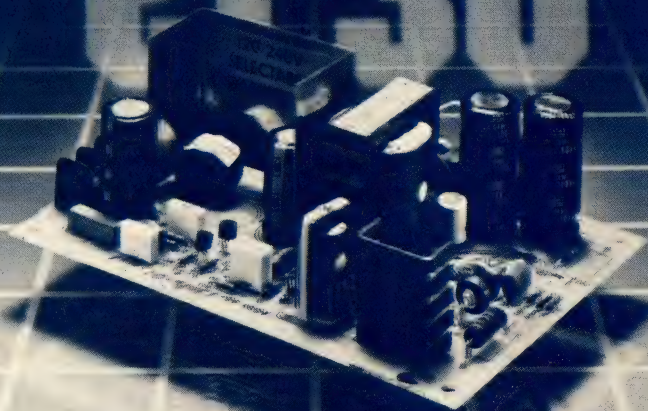
LOGIC ANALYZER. Furnishing soft-key operation, Model PM3551 35-channel, 3-clock, 15-MHz state analyzer can provide as many as 59 state channels as well as eight

50-MHz-channel and four 300-MHz-channel timing facilities. Disassembly options include serial and IEEE-488 interfaces. Comprehensive triggering facilities are provided, as are selective data capture on software flow boundaries and transitional timing. Cursor prompting and menu or data display, selected using single-function keys, are also included. A high-level structured language facilitates triggering. The unit supplies If-Then-Else branching and counting and conditional branching to any stage in the trigger route. Also featured are selective data acquisition and a video monitor with split screen and soft scrolling. **Philips Test & Measuring Instruments Inc**, 85 McKee Dr, Mahwah, NJ 07430. Phone (201) 529-3800.

Circle No 276

SL30

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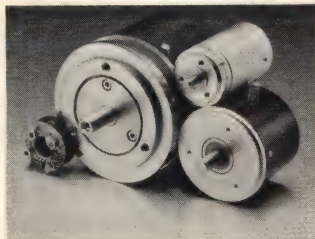
selection permits direct reading of a measured parameter; for swept-frequency operation and special display modes, amplitude and frequency autoranging facilities can be overridden. The analyzer can drive an X-Y recorder that plots amplitude/phase or group-delay measurements, SWR, impedance or admittance—in real and imaginary components and in Cartesian or polar form. An IEEE-488 option permits programmable operation. **Polarad Electronics Inc.**, 5 Delaware Dr, Lake Success, NY 11042. Phone (516) 328-1100.

Circle No 277



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DISTORTION - MEASURING SYSTEM. A comprehensive audio-distortion and noise-measuring system, Model 3501 furnishes total-harmonic-distortion figures to better than 0.0008% (-102 dB) and noise measurements to better than -120 dBm. Its built-in generator can deliver 30 dBm max to a 600 Ω load over the instrument's frequency range of 10 Hz to 100 kHz. Providing automatic operation and fast settling time, the unit can be configured with a fully balanced input and output to interface to telecommunications, broadcast and professional audio equipment. Four noise-weighting filters can be selected from a library of widely used weighting curves to meet international noise-measurement standards. Other features include a frequency-selective voltmeter, variable-bandwidth mode and optional intermodulation-distortion measurement. From \$2100. Delivery, 4 to 10 wks ARO. **Amber Electro Design Inc.**, 4810 Jean Talon St West, Montreal, Quebec, Canada H4P 2N5. Phone (514) 735-4105.

Circle No 278

CIRCLE NO 127

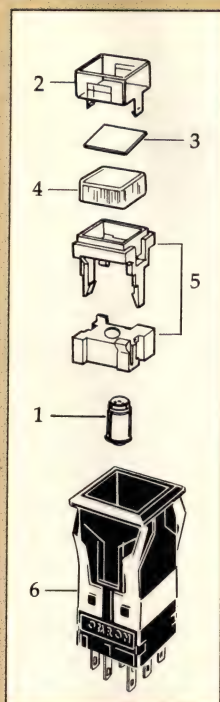
Omron's LED-illuminated pushbutton switches... human-engineered for increased communication

First and foremost, a lighted pushbutton must communicate a condition clearly to the operator. To avoid operator error, it must also emit a sufficient amount of light. And when pressed, it must engage immediately, assuring precise control.

But some pushbuttons are too dim. Some can only be seen in a narrow viewing range. And others will engage only if pressed in the exact center, which invites error when multiple, rapid commands are initiated.

Now there's Omron's new A3 series LEDs... illuminated pushbutton switches designed for *total* communication. A3s are the brightest LED switches available. They also offer the broadest viewing angle. And, regardless of where they're pressed, they engage every time.

Take a closer look at any A3 switch and you'll see why they communicate more effectively.



A unique LED array (1) broadens and intensifies brightness (visibility up to 200 feet) without sacrificing low-power benefits (uses as little as 15 milliamps).

The colored lens (2) and legend plate (3) can easily be seen from all sides. The lens can be removed by fingertip for quick changes of the legend plate. The colored plate (4) intensifies and broadens the light, expanding the viewing angle to a full 120 degrees. And a special plunger case design (5) engages the switch at any angle—no matter where it is touched. These features, plus a superior switch design (6), combine to provide high reliability and positive switch performance. A3s are also available with fail-safe relamping mechanisms which permit switch removal without shutting down the panel.

The bottom line: reduced operator errors... lower operating costs... high visibility... and extended switch life (up to 1 million operations).

Our broad line of pushbuttons and optional accessories includes: incandescent lamp-illuminated switches; as well as barriers, switch guards, sockets and seal covers for all models.

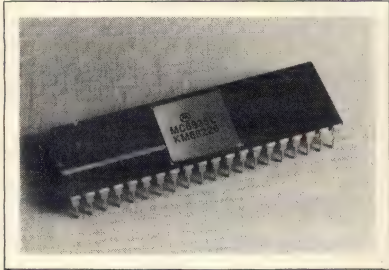
For detailed information, contact Omron Electronics, Inc., Control Components Division, 650 Woodfield, Schaumburg, IL 60195. Telephone: 312/843-7900.



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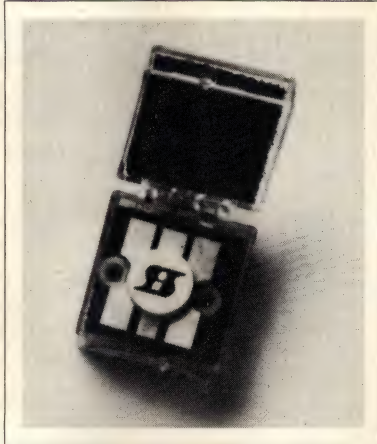
CIRCLE NO 128



CRT CONTROLLER. A ROM-based MOS unit, the MC6835 supports two screen formats; provides alphanumeric, semigraphic and full-graphic capabilities; and has a programmable cursor register for control of cursor position. A refresh (screen) memory can be multiplexed between it and a μP , eliminating the need for line buffers or external DMA devices. Other features include mask-programmable interlaced or noninterlaced modes; a 14-bit-wide refresh address, which accommodates as much as 16k bytes of refresh memory; a 5-bit-wide row address, which permits as many as 32 scan-line character blocks; and 5V operation. Pin compatible with the MC6845, the unit comes in 1.0-, 1.5- and 2.0-MHz versions. \$5.95 (1000). **Motorola Inc.**, MOS Microprocessor Div, 3501 Ed Bluestein Blvd, Austin, TX 78721. Phone (512) 928-6863.

Circle No 302

RF POWER FETs. DVD Series n-channel enhancement-mode power FETs spec 220V drain-to-source breakdown voltage (BV_{DS}). Delivering 150W at 100 MHz and 120W at 175 MHz, they provide power gains of 17 and 10 dB, respectively, when operated with V_{DD} of 100V. The parts' high drain-to-source voltage ratings (V_{DS}) suit them for Class A, B, C, D and E amplifier circuits operating to 300 MHz in HF/VHF military, industrial, aerospace-



radar and communications equipment. Maximum power-dissipation rating equals 240W, and the devices can absorb reflected power from load mismatches equivalent to a 30:1 VSWR. DVD150T, \$72 (100). **Siliconix Inc.**, Box 4777, Santa Clara, CA 95054. Phone (408) 988-8000.

Circle No 303



A/D CONVERTER. The monolithic triple-diffused TDC1025LIC is the IC version of its manufacturer's 8-bit, 60M-samples/sec flash-converter board. The 32,000-mil² chip dissipates approximately 2W using a -5.2V supply and accepts analog input signals with a 25-MHz bandwidth. Input range equals 2V; aperture error, <20 psec. Output drivers are open-emitter ECL. Differential outputs limit power-supply switching transients and

optimize data transmission. You can produce two's-complement and inverted data-output coding by inverting the output connection. \$485 (100). **TRW/LSI Products**, Box 2472, La Jolla, CA 92038. Phone (714) 457-1000. TLX 697957.

Circle No 304



BIPOLAR TRANSISTOR. For linear applications such as voltage regulators, power amplifiers and deflection-yoke drivers, the LT10 uses ion-implanted ballasting and can dissipate 200W at collector voltages to 200V without safe-area restrictions; all parts are tested at 200W for 0.5 sec (without heat sink) with full rated voltage. f_T equals 80 MHz, and the device furnishes speed and secondary-breakdown resistance comparable to that of VMOS transistors while retaining the low saturation voltage (0.65V at 12A) of bipolar transistors. Conservatively rated for a maximum junction temperature of 200°C, the unit has its silicon die separated from the copper heat spreader by a molybdenum layer to match expansion coefficients and utilizes a hard gold-eutectic die attach. Oxide-passivated junctions and a nitride-passivated die are also employed. \$14 for the 140V version; \$15.40 (100) for the 200V part. **National Semiconductor Corp.**, 2900 Semiconductor Dr, Santa Clara, CA 95051. Phone (408) 721-5000. TWX 910-339-9240.

Circle No 305

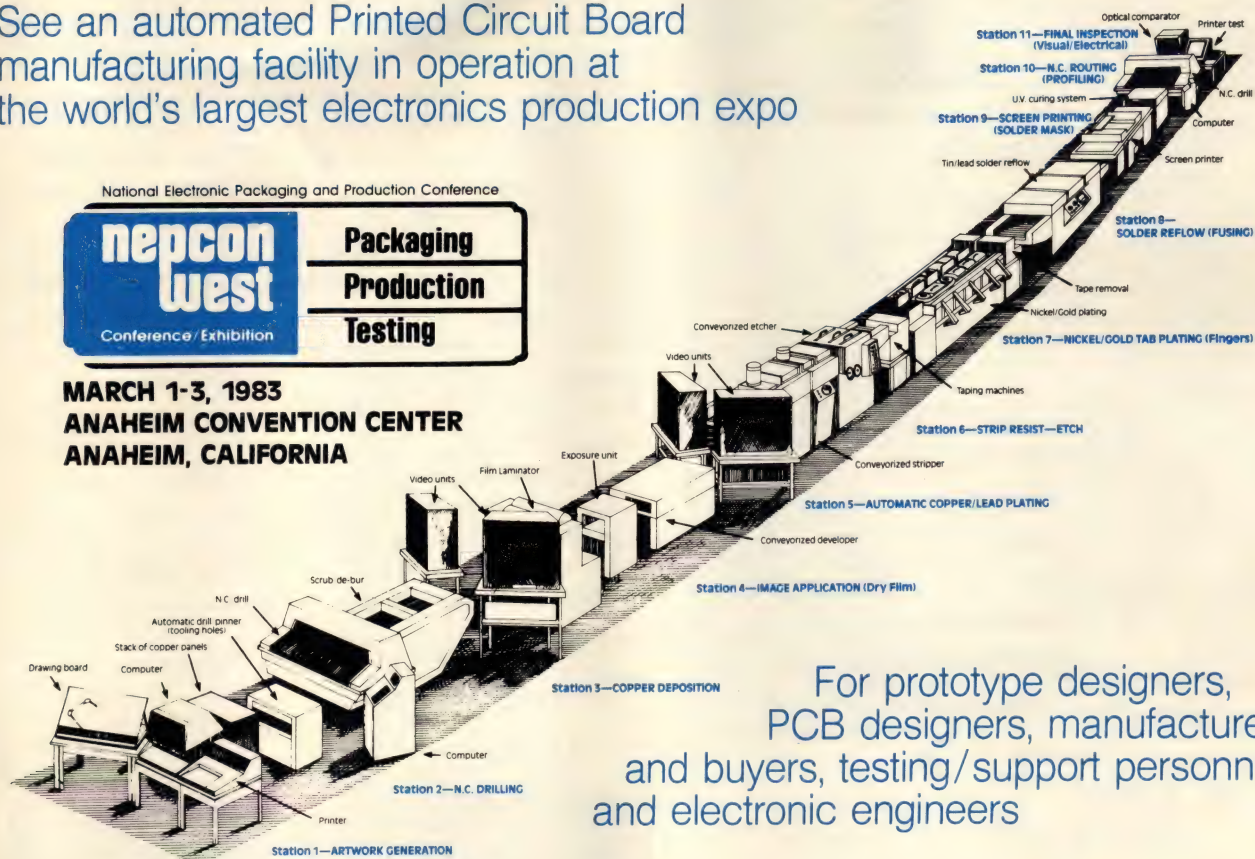
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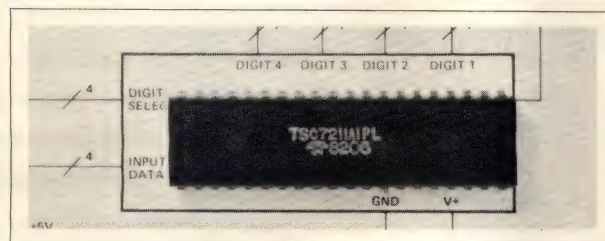
Contact Harris Semiconductor Analog Products Division, P.O. Box 883 MS 53-035, Melbourne, Florida 32901

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CIRCLE NO 130

ICs & Semi-conductors



LCD DRIVER. A 4-digit LCD decoder and driver IC, the TSC7211A incorporates four binary-to-7-segment decoders with latches, an RS oscillator with divider chain, an LCD backplane driver and 28 LCD segment drivers on a 110×123-mil die. It accepts nonmultiplexed BCD or binary input data, latches and decodes a 4-bit input word into 7-segment Code B output format and produces a display of zero to nine and E, H, L, P and -. Operating supply voltage specs at 3 to 6V with 50-μA max current drain. The 28 outputs have a zero dc drive component for longer LCD life. The TSC7211A1PL in 40-pin plastic DIP operates over -20 to +85°C. \$5.50; TSC7211A/Y chip, \$3.35 (100). **Teledyne Semiconductor Corp.**, 1300 Terra Bella Ave, Mt View, CA 94043. Phone (415) 968-9241. TWX 910-379-6494.

Circle No 307

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A/D PERIPHERALS. CMOS A/D-converter ICs for 8- and 16-bit μ P systems, the 8-line, 3-state TL530, -531, -532 and -533 include on-chip multiplexers and 16-bit analog and digital data registers. Complete data-acquisition systems, the bidirectional-data-bus TTL-compatible parts provide on-chip circuitry to replace an 8-bit A/D converter, multiplexer, sample/hold and control ICs. Models TL530 and -531 40-pin devices accept as many as 15 analog inputs and 12 digital inputs. The TL532 and TL533 are 28-pin versions that can handle as many as 11 analog and six digital inputs. In all versions, six of the inputs are multipurpose analog or digital. TL530 and -532 devices perform $\pm 1/2$ -LSB A/D conversions. TL531 and TL533 units are guaranteed to provide a maximum error of ± 1 LSB. All parts feature 300-μsec max access and conversion times (at 85°C). TL530, \$8.97; TL531, \$4.81; TL532, \$7.34; TL 533, \$4.32 (100). **Texas Instruments Inc.**, SC-389, Box 202129, Dallas, TX 75220. Phone local office.

Circle No 306

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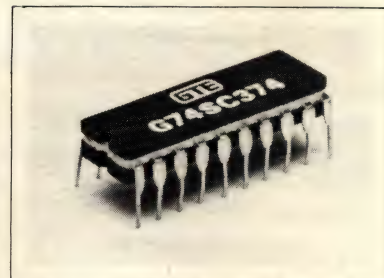
QUAD TRANSISTORS. Improved versions of MPQ12221/22 npn and MPQ2906/07 pnp Series devices, these A-suffixed parts feature improvements in voltage breakdown (V_{CE0}) and h_{FE} ratings, boosting V_{CE0} 10V for npn devices and 20V for pnp units. h_{FE} min at 10 mA specs at 35 and 75 for MPQ2221A and -2222A devices, respectively, and at 40 and 100 for MPQ2906A and -2907A parts, respectively. $V_{CE(SAT)}$ equals 1.6V for pnp units, 1.0V for npn devices. Typical gain-bandwidth product equals 350 MHz; total power dissipation for each transistor ($T_A=25^\circ\text{C}$) equals 0.5W. MPQ2221A and MPQ2906A, \$1.98 each; MPQ2222A and MPQ2907A, \$2.15 each. **Motorola Semiconductor Products Inc.**, Box 20912, Phoenix, AZ 85036. Phone (602) 244-6455.

Circle No 308

CURRENT-LIMITER DIODES. The five devices in the JR Series furnish a choice of peak operating voltages ranging from 135 to 240V and come in TO-92 plastic packages. Each specifies limiting as low as 0.9V, dynamic impedance of 3 M Ω and 360-mW power dissipation. With drift-free performance over temperature and time, the units operate over -55°C to $+135^\circ\text{C}$. You can use one of these devices instead of two J552-type diodes in series to serve a wide range of applications. \$0.34 to \$0.39 (10,000), depending on peak-voltage rating. **Siliconix Inc.**, Box 4777, Santa Clara, CA 95054. Phone (408) 988-8000.

Circle No 309

CMOS FLIP FLOP. Pin-for-pin compatible with standard 74LS edge-triggered flip-flop circuits,



the D-type G74SC374 operates at speeds approaching those of low-power-Schottky and TTL bipolar devices. Produced with the ISO-CMOS process, it has low input-power requirements and features improved noise margins and typical propagation-delay time of 55 nsec. Available in industry-standard 20-pin Cerdip and plastic packages, the part operates from a 5V supply over -40 to $+85^\circ\text{C}$. \$4 in Cerdip; \$2.65 (100) in plastic. **GTE Microcircuits**, 2000 W 14th St, Tempe, AZ 85281. Phone (602) 968-4431.

Circle No 310

MOS SCRs. MCR1000 Series devices furnish a power MOSFET's advantages of high input impedance and fast turn-on time and the regenerative latching action of a thyristor. They were developed from vertically structured TMOS transistors by changing the substrate doping from n^+ to p^+ . The 4-layer structure (pnpn) creates the 2-transistor equivalent with the latching feature of SCRs and the gate-drive and switching characteristic of MOS transistors. For very-high-speed, high-current-pulse applications, the 15A units feature dv/dt of 1000V/ μsec at $T_J=125^\circ\text{C}$ and 200-nsec max switching at $T_J=250^\circ\text{C}$. \$5.20 to \$6.90 (100), depending on peak forward blocking voltage. **Motorola Semiconductor Products Inc.**, Box 20912, Phoenix, AZ 85036. Phone (602) 244-6437.

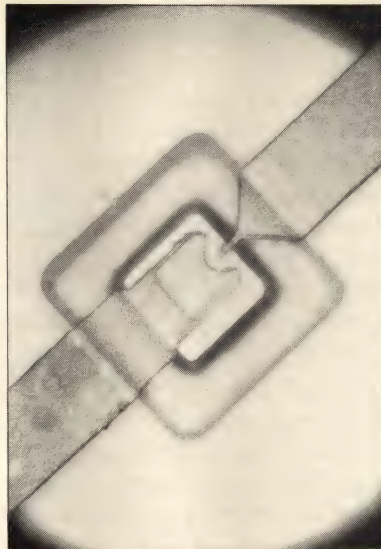
Circle No 311

Millimetre-wave beam-lead diodes accommodate production handling

Designed for use in millimetre-wave receiver circuits, the DC1346 beam-lead mixer and detector GaAs diodes feature good mechanical strength for ease of handling in production.

The devices make use of a low-melting-point glass frit for low capacitance and strength and spec typical beam-pull values of 4g. Aimed at applications such as terminally guided submunitions, they furnish 2.5- μ m junction diameters designed for 60- to 300-GHz operation and spec 2500-GHz cutoff frequency.

Key characteristics include series resistance of 6 Ω (10 Ω max), total capacitance at zero



Designed for 60- to 300-GHz use, these beam-lead diodes feature 4g pull strength.

bias of 0.03 pF (0.04 pF max) (junction capacitance of 0.01 pF and stray capacitance of 0.02 pF), breakdown voltage of 2V min at 10 μ A, and ideality factor of 1.15. Maximum input power equals 150 mW cw, 300 mW pk (estimated).

The glass-strengthened package measures 300 μ m square and has 250- μ m leads. £60 to £90 (1000). Delivery, 16 wks ARO.

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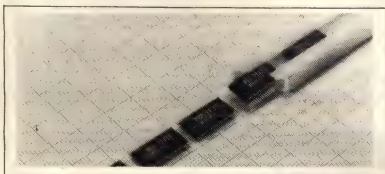
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LCD DRIVER. The single-chip PCF2112 duplex device can drive LCDs with 32 segments. Accepting serial data input from a μP , it's aimed at low-voltage applications. The device requires a 2.25 to 6.5V supply and consumes 10 μA ; it works over -40 to $+85^\circ\text{C}$. Encapsulations include 40-pin plastic DIP or plastic flatpack; the latter is the same as the 24-pin SO arrangement but with leads on a 0.762-mm (30-mil) pitch. **NV Philips' Gloeilampenfabrieken**, Elcoma Div, Box 523, 5600 AM, Eindhoven, The Netherlands. Phone (040) 79 11 11.

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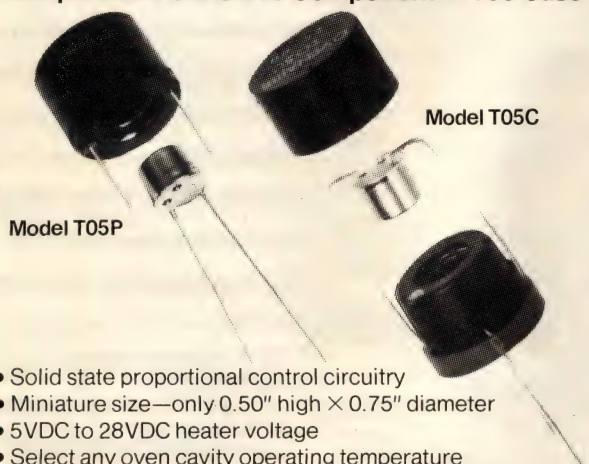
MULTIMETERS. Handheld $3\frac{1}{2}$ -digit DMMs in the 2000 Series accommodate applications in maintenance, providing a variety of ergonomic features. They feature probe connections on the top of the case with direct-entry prods for 1-handed operation, plus $3\frac{1}{2}$ -digit LCDs located at the base to make the most of available light—when probing points inside a cabinet, for example. Functions are selected via two dustproof slide switches, and a 3-position stand allows you to use the devices on a bench or hang them from a hook. Two models (£69 and £85) are designed for general-maintenance applications, with the lower priced version incorporating a buzzer socket for simple reference to the display and the more expensive unit having a special current socket (with 10A



range) plus alarm that indicates if you're in the wrong mode. A third instrument (£97) especially serves vehicle testing and features an option kit including temperature and high-current (1500A) facilities. **Thorn EMI Instruments Ltd**, Archcliffe Rd, Dover, Kent CT17 9EN, UK. Phone (0304) 202620.

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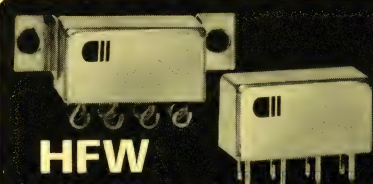
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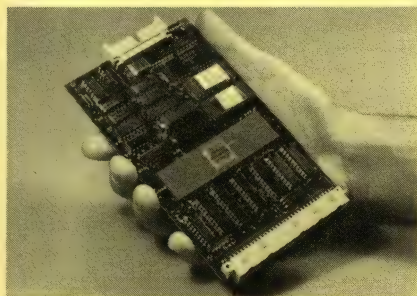
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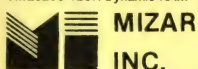
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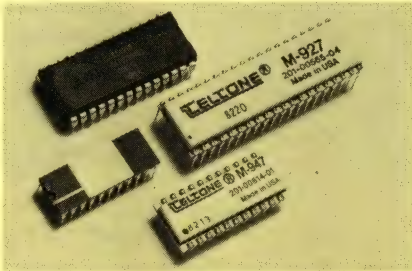
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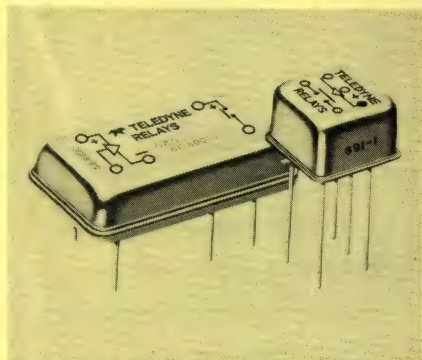


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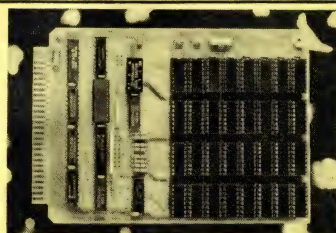
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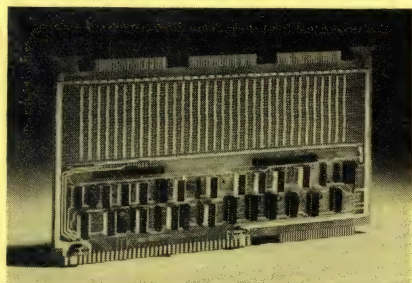
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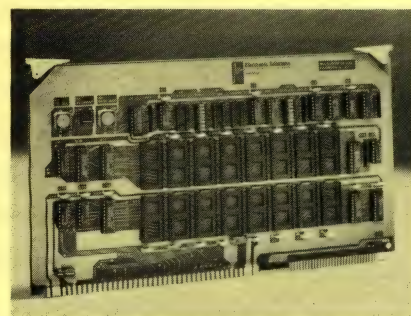
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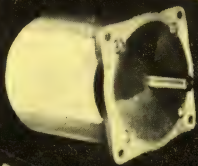
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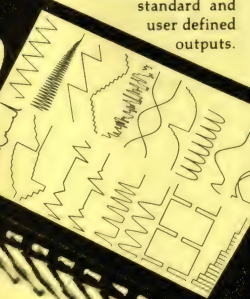
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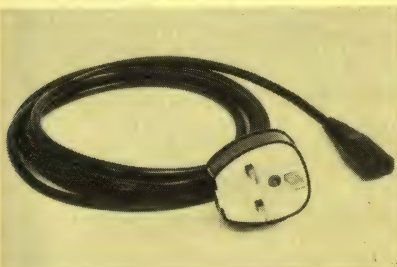
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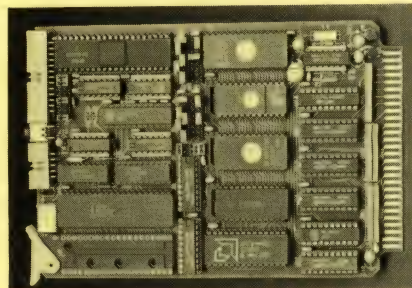
FTH-A



MZH

XF-H

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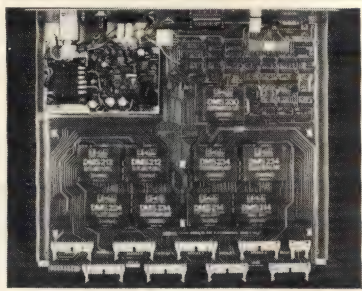


8001 CPU The 8001 CPU is an 8088 based, STD bus card. Provisions for an 8087 arithmetic coprocessor and four 28 pin sockets for RAM, PROM, EPROM, or E²PROM allow unusual versatility. Two RS-232-C channels and an interrupt controller are provided. Available address space is 20 bits wide. Up to 64K of on board memory can be mapped outside of the 64K available on the STD bus. Flying bus allows access to the upper four bits.

Electron Machine Corp.

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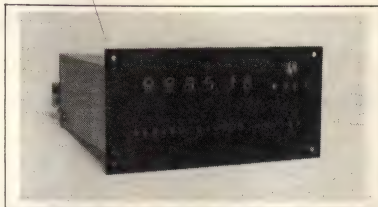


IEEE-488 DATA ACQUISITION.

The DMS550A data-acquisition system can digitize 128 analog signals with resolution of 13 bits (12 bits plus sign). Phase-locked-loop circuitry synchronizes the ADC's integration period to mains frequency (50 or 60 Hz) and allows the card to achieve series-mode noise rejection >60 dB min. Gain is programmable from 1 to 2048 in 12 ranges, permitting digitization of analog inputs from ± 5 mV to ± 10.24 V FS. Software control of input

configuration accommodates single-ended or differential inputs on each channel. The card is configured via eight plug-in modules. £972. **Di-An Micro Systems Ltd**, Mersey House, Battersea Rd, Heaton Mersey, Stockport, Cheshire SK4 3EA, UK. Phone (061) 442 9768.

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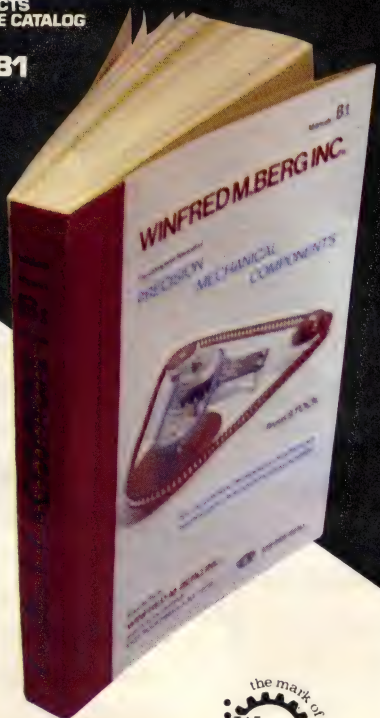
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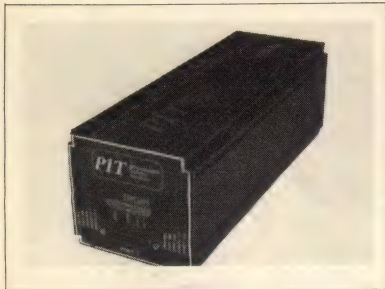
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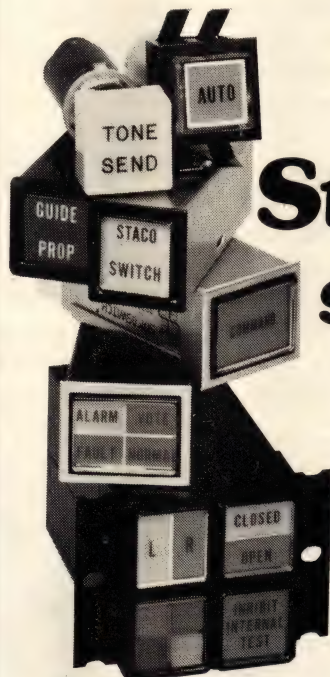
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IC second sources

This short-form catalog highlights its supplier's four expanded product areas: military ICs, dual transistors, op amps and DACs. It provides specs for 6- to 18-bit DACs and OP-01 to OP-37 op amps. The 12-pg booklet provides packaging data and lists performance/temperature ranges for second-source parts for Analog Devices, PMI, Hybrid Systems, Siliconix, Harris and Intersil devices. It

describes devices that come in die form and with -883B processing. **Micro Power Systems Inc.**, 3100 Alfred St, Santa Clara, CA 95050.

Circle No 290

Designing linear semicustom ICs

Designing Low-Frequency Filters on the CMOS Monochip discusses semicustom-IC theory and design techniques and provides examples of low-frequency switched-capacitor filters that can be implemented on the MLA, a CMOS Monochip. Low-pass-, high-pass- and bandpass-filter examples are also included. The 22-pg app note examines design tables, computer-analysis programs and breadboard-construction techniques to facilitate the de-

sign of switched-capacitor units that operate below 25 kHz. **Interdesign Inc.**, 1500 Green Hills Rd, Scotts Valley, CA 95066.

Circle No 291

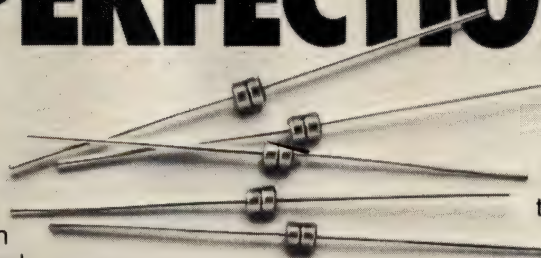


Recognizing broadcast code

This 4-pg app note discusses two broadcast recognition circuits (BRCs) for use with a MIL-STD-1553 Manchester II

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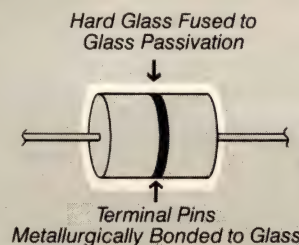
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Literature

converter. With block diagrams, it examines two BRCs that recognize and flag a broadcast or command-mode code. The booklet explains how these circuits operate with the Bus-8937, a MIL-STD-1553B command/response Manchester II unit that provides multiple functions in one hybrid package. A table summarizes characteristics of 16 MIL-STD-1553-related products, listing type, size and features. **ILC Data Device Corp.**, 105 Wilbur Pl, Bohemia, NY 11716.

Circle No 292

Gate-array options

This 10-pg brochure outlines one manufacturer's semicustom CMOS LSI/VLSI gate-array design and fabrication services. It describes how the firm avoids

problems in design support, cost, turnaround time and second sourcing when converting discrete or MSI-level TTL circuits to custom or semicustom ICs. Highlighting a CAE system that integrates design, simulation, layout, tooling and test-generation functions, the booklet explains that the units' 3- μ m polysilicon gate lengths, coupled with 2-layer metallization, provide design latitude while holding delay times to 3 to 5 nsec typ. **Storage Technology Corp., Microtechnology Div.**, 2270 S 88th St, Louisville, CO 80028.

Circle No 293

Specs characterize shaft couplings

Illustrating two lines of flexible miniature shaft couplings and typical applications, this 4-pg



brochure highlights custom bores; a chart details available sizes. The booklet describes a high-torque series with maximum ratings of 7 to 480 oz-in. and a standard series with ratings of 1.6 to 226 oz-in. It explains that because the units' flexible element consists of a bellows, the couplings can be compressed or extended axially while transmitting torque. **Servometer Corp.**, 501 Little Falls Rd, Cedar Grove, NJ 07009.

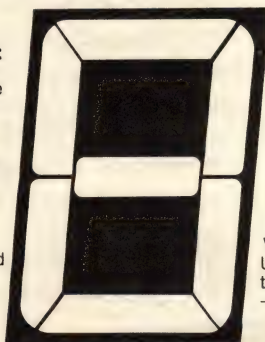
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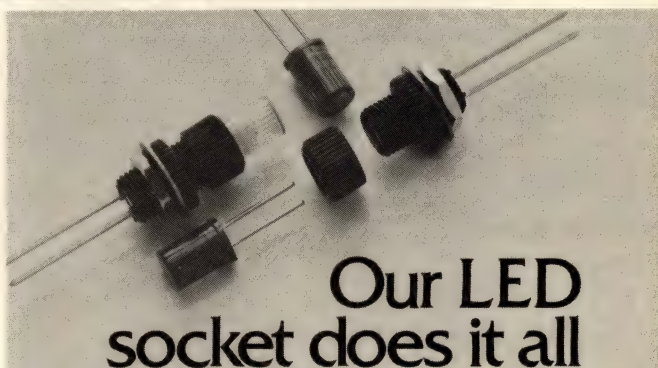


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Literature



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Showcasing a line of Super Isolation Transformers and ac line conditioners with ratings of 100 VA to 60 kVA, this 16-pg catalog looks at ac-power problems and the line-conditioning devices that solve them. It divides those problems into five areas: blackouts, brownouts, fluctuating voltage, noise or transients, and combinations of these factors. Graphs plot common-mode noise attenuation for static and line conditioners; diagrams depict plug and socket configurations. Photos accompany product - spec charts. **Gould Inc**, Electronic Power Conversion Div, 2727 Kurtz St, San Diego, CA 92110.

Circle No 295

Electrical standards in world trade

This directory of international electrical standards, published in association with the International Electrotechnical Commission (IEC), includes an analysis of how world standards facilitate international trade; a review of regional standardization in Western Europe, Eastern Europe and the Pacific; and a profile of national standards in major exporting countries. Summarized are standards and approval marks imposed by governments and other authorities in the 43 IEC member countries that regulate the manufacture, sale

and use of electrical equipment. One section speculates on future trends in electrical standardization. 70 SF. **IEC**, 1-3 Rue de Varembe', 1211 Geneva 20, Switzerland.

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Measuring RF power

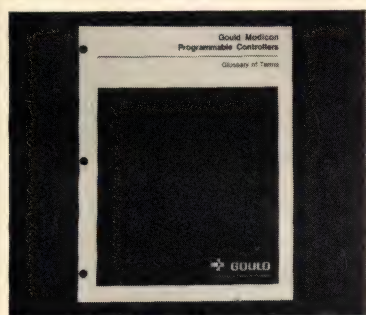
Catalog SF-83 outlines capabilities of Thryline wattmeters, coaxial loads, RF-absorption wattmeters and high-power attenuators spanning 0.5 to 2300 MHz and milliwatts to 250 kW. Detailed are RF Power Analyst instruments and a multirange directional wattmeter with seven power levels per plug-in element. The 4-pg brochure lists key parameters for each instrument featured. **Bird Electronic Corp**, 30303 Aurora Rd, Cleveland, OH 44139.

Circle No 297

Data details gate-array design

This 600-plus-page report examines various ways of implementing LSI technology and profiles more than 65 gate-array vendors. With more than 100 charts and figures, it analyzes the advantages and disadvantages of using gate arrays, supported with case studies. An overview of design approaches introduces a discussion of ECL, TTL and CMOS examples, I/O pin requirements, and testing and packaging options. Concluding the study is a chapter on the future of gate arrays that considers such issues as resource shortages and CAD-tool development and discusses such performance factors as density, speed, power and cost. \$1250. **Electronic Trend Publications**, 10080 N Wolfe Rd, Suite 372, Cupertino, CA 95014.

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Programmable-controller glossary

This 7-pg glossary defines terms related to the use of programmable controllers. It explains the terminology used to describe the units' operation and that of related systems. Terms such as bit rotate function, dump, register and transitional contact are discussed. **Gould Inc.**, Modicon Programmable Control Div, Box 83-SVS, Andover, MA 01810.

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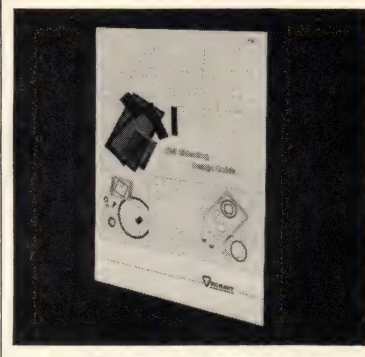
Packaging capacitors

New Concepts in MLC Packaging describes a multilayer-ceramic-capacitor (MLC) design that incorporates buried capacitors in a multilayer interconnection substrate in an array configuration. Photos, diagrams and tables illustrate the design and highlight the substrate, a high-K replacement for conventional alumina that's compatible with conventional air-fired thick-film materials. The 8-pg discussion also examines custom thick-film multilayer interconnections and MLC arrays. **AVX Ceramics**, Box 867, Myrtle Beach, SC 29577.

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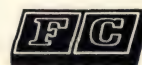
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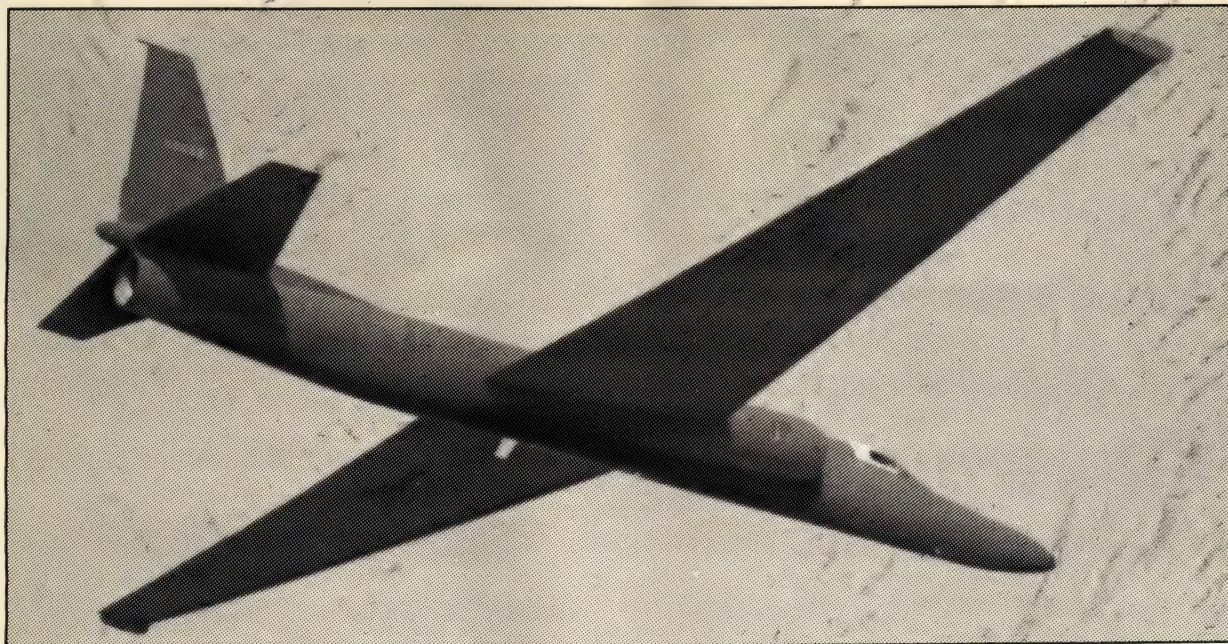
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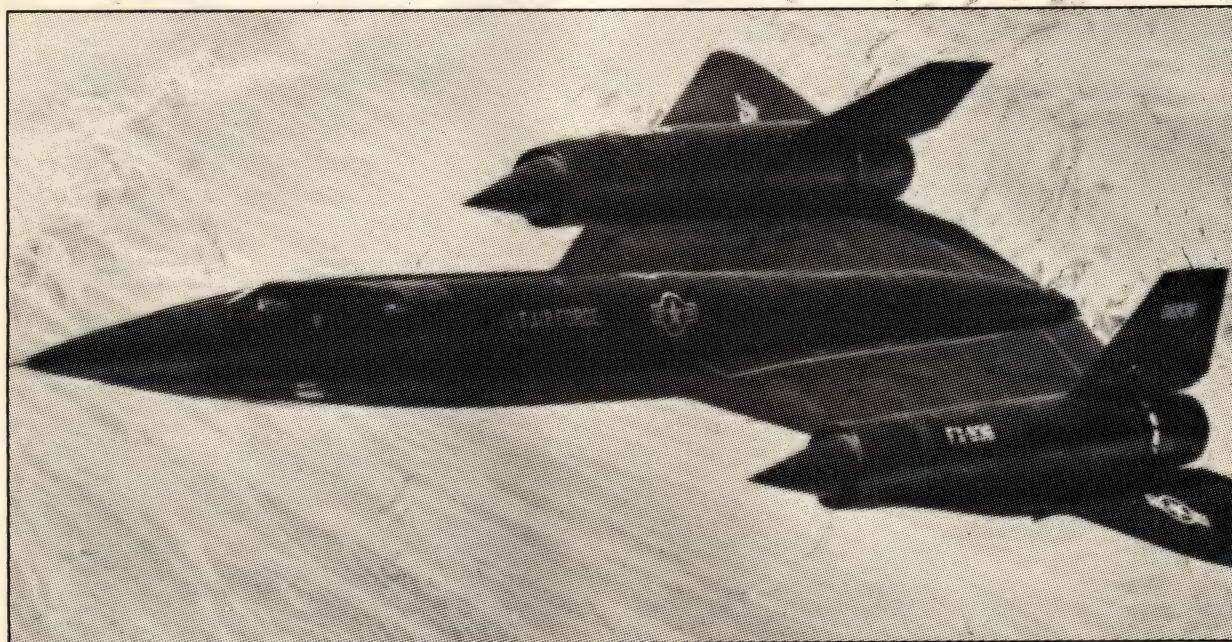


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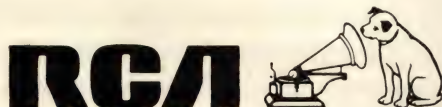
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Looking Ahead: Trends and Forecasts

Floppy-disk-drive sales to rise to \$4.6B in '86

Despite strong challenges from hard-disk drives and cartridge-tape systems, the floppy-disk-drive market will expand at a compound annual rate of 28.7%, growing from \$1.3 billion in 1981 to \$4.6 billion in 1986 (valued in OEM prices). And although an increasing percentage of floppy-disk users are turning to competitive storage technologies, particularly for word-processing and industrial computer applications, the substantial growth rate of systems utilizing floppies will support healthy market growth through 1986, says Venture Development Corp (VDC), Wellesley, MA.

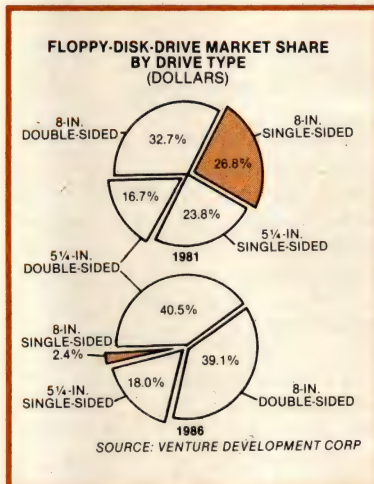
Personal-computer owners form the critical floppy-disk-drive user group, an end-user market segment that accounted for approximately 41% of all units shipped in 1981. Single-sided drives, however, will lose their current market dominance to double-sided 5¼- and 8-in. units by 1983, and the double-sided systems will capture 79.6% of the market by 1986.

Single-sided 8-in. drives' market share will shrink from 1981's 26.8% level to 2.4% in 1986. Sales of 5¼-in. single-sided floppies, however, will still account for 18% of the market at that time, losing only 5.8% in market share over the period.

VDC sees some clouds gathering on the horizon for the floppy-disk-drive industry. Many vendors that once had a considerable market share have left the market completely or have de-emphasized floppy disks. Moreover, many manufacturers, in an effort to meet users' demands for more competitive technology, have added hard-disk drives to their prod-

uct lines. In a further threat to the floppy-disk-drive market, important purchasers such as Datapoint and Tandy have started producing their own.

However, it will be the market success of half-height and microfloppy drives (those smaller than 5¼ in.) that will determine the course of the floppy-disk-drive industry, VDC predicts. In this respect, says the firm, the current battle over microfloppy standards

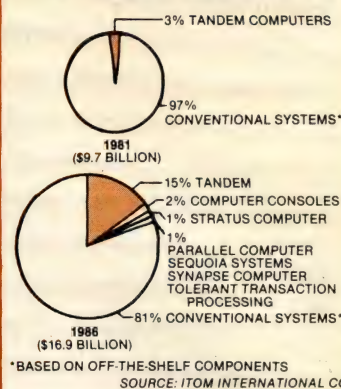


(EDN, December 17, 1982, pg 114) is counterproductive and only weakens the industry.

Analysts offer varying opinions on whether floppy-disk-drive prices will continue their decline in 1983. Spokesmen for Tandon Corp and Kierulff Electronics Inc (a Tandon distributor) foresee a bottoming out of 5¼-in.-drive prices. However, analysts at Hamilton/Avnet, Wang Laboratories and Shugart Associates cite competitive pressures or advancing technology as causes for further price reductions.

At Shugart Associates, public relations specialist Jim McCartney predicts that half-height 5¼-in. drives are the units most likely to be affected by price cuts.

WORLDWIDE MARKET FOR ON-LINE FAULT-TOLERANT COMPUTER SYSTEMS



Fault-tolerant computers: \$16.9B market seen in '86

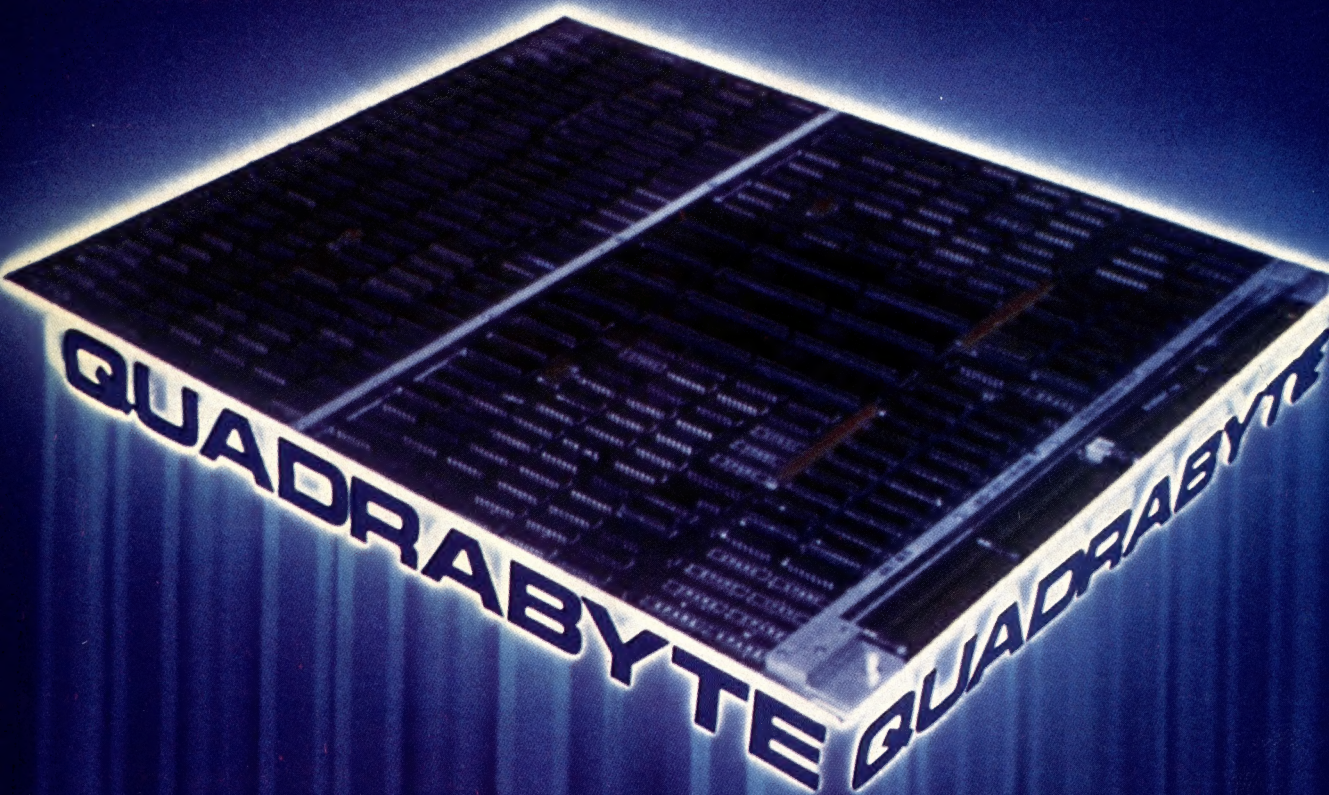
Fueled by increasing demands from banks and other large data-processing users for no-down-time computer systems, the market for fault-tolerant computers will grow vigorously to \$16.9 billion in 1986, predicts ITOM International Inc, Los Altos, CA.

Microprocessor-based fault-tolerant systems now entering the arena, such as the N+1 from Synapse Computer Corp (Milpitas, CA), will be vying with minicomputer-based systems from Tandem Computers Inc and with conventional main-frame-centered schemes for a share of the burgeoning transaction-processing market, estimated by Dataquest Inc to be growing 40% annually.

Redundant-μP-oriented firms such as Synapse, however, will have to strive hard to match Tandem's 15% (\$2.5 billion) 1986 market share, says ITOM president Omri Serlin.

Material for this page developed from *Electronic Business* magazine and other sources by Jesse Victor, Senior Staff Editor, and Joan Morrow, Assistant Editor.

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Our forty years of experience in providing **affordable technology** to the electronics industry is exemplified in our membrane switch systems, which offer you: extremely high reliability; easily cleaned, abrasion-resistant graphics that can be tailored to your specific aesthetic requirements; sealed construction that virtually eliminates environmental contamination problems; high circuit densities to give you maximum usage of available panel area; easy, one-step mounting and termination through the use of a number of Molex flat flex cable connectors; modest tooling charges for custom panels (with prototyping in **weeks**, not months), and a price that will keep your product competitive.



... Affordable Technology

For more complete information, call or write:
Molex Incorporated, 2222 Wellington Court,
 Lisle, Illinois 60532 (312) 969-4550

From the usual...

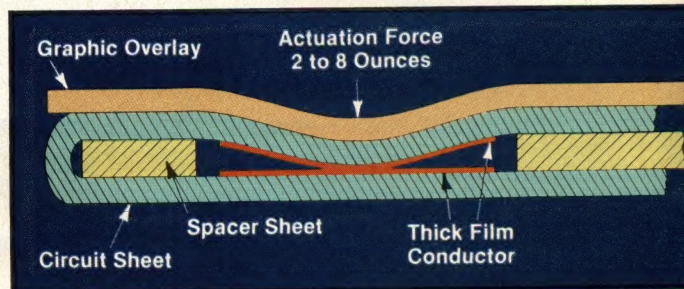
We also have a wide variety of standard membrane switches in the most popular size and circuitry options readily available from our extensive network of stocking distributors.

To the unusual...

Molex offers not just the membrane switch but all the interconnecting devices that your system may require... from connectors to cable to audio tone transducer mounts that provide audible feedback for your membrane device.

For those applications where a membrane switch isn't the answer, we offer a complete line of pushbutton switches with current ratings to 15 amps.

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